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DEPARTMENT OF THE INTERIOR  
UNITED STATES GEOLOGICAL SURVEY  
— GEORGE OTIS SMITH, DIRECTOR —

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THIRTY-SECOND ANNUAL REPORT  
OF THE  
DIRECTOR OF THE UNITED STATES  
GEOLOGICAL SURVEY  
TO THE  
SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR  
ENDED JUNE 30

1911

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# THIRTY-SECOND ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

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GEORGE OTIS SMITH, *Director.*

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The appropriations for the work of the United States Geological Survey for the fiscal year 1910-11 comprised items amounting to \$1,477,440. The plan of operations was approved by the Secretary of the Interior and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

## SPECIAL FEATURES.

### WORK ON THE PUBLIC LANDS.

The scientific investigations of the Survey have been continued along lines similar to those followed in other years and the usual amount of contributions have been made to the knowledge of geology and related subjects. Among the special features of the year's activities the work in the public-land States should be given first place. The field examination of the public lands has become an increasingly important feature in the Survey's work, yet the standard attained is so dependent on past and present scientific investigations that the credit is necessarily given to the same field organization for both the scientific and the applied results.

In the last 12 months the amount of work done, both in field investigations contributing to the classification of the public lands and in the preparation of the results of land classification, has exceeded that done by the Survey during any preceding year. The field investigations and examinations have been more extensive and more detailed and reports covering a wider range of subjects have been prepared and submitted to the Secretary's office and to the General Land Office and the Office of Indian Affairs.

An illustration of the extent to which this contribution to public-land administration depends on the accumulated results of the field work of the Survey is afforded by the land-classification reports that are based in large part on the work of the water-resources branch.



These include reports to the Secretary of the Interior made in connection with the designation of nonirrigable lands under the enlarged-homestead act and with recommendations for the withdrawal from entry of lands valuable for water-power or reservoir sites under the withdrawal act, as well as similar reports furnished the Commissioner of the General Land Office on right-of-way applications and on applications for segregations of irrigable lands under the Carey Act. The preparation of these reports requires wide and intimate knowledge of the conditions existing in the public domain, as well as engineering judgment of a high order. Definite results concerning much of this work could not have been attained had not records of the surface and underground water resources of the public domain been available—records which represent the accumulated results of work done by the Geological Survey under appropriations covering many years.

The extent to which the work performed in other years by the geologic, topographic, and water-resources branches of the Survey has been utilized to the advantage of the public can be inferred from this year's records of the land-classification board, which in public-land matters acts as the clearing house of the Survey's field service.

#### **PUBLIC-LAND LEGISLATION.**

##### **NATURE OF THE GEOLOGICAL SURVEY'S WORK.**

The increasing share which the Geological Survey has been asked to take in the public-land administration by the Interior Department has brought many of the problems connected with the public-land laws more directly to the attention of those charged with the work of this bureau. For over 30 years, however, these problems have interested the Federal geologists, who have had exceptional opportunities for first-hand observation in nearly all the important mining districts of the country, and for almost as long a period the engineers of the Survey have been in touch with the irrigation and power developments in the public-land States. This intimate experience with both field conditions and administrative problems justifies an expression of opinion concerning the land laws, which, it is believed, will be appropriate to this administrative report. To a large extent the principles here presented and the specific provisions advocated have been expressed in memoranda submitted by the Geological Survey to the Secretary of the Interior during the last four years.

##### **PROPOSED AMENDMENT OF PUBLIC-LAND LAWS.**

##### **PURPOSES AND MEANS OF AMENDMENT.**

The objects to be sought by amendment of the public-land laws are, first, purposeful and economical development of resources for

which there is present demand, with retention of such control as may insure against unnecessary waste or excessive charges to the consumer, and, second, the reservation of title in the people of all resources the utilization of which is conjectural or the need of which is not immediate. The means that are essential to the attainment of these objects are, first, the classification of the public lands, second, the separation of surface and mineral rights, and third, the disposition of the lands on terms that will secure the highest use, enforce development, and protect the public interest. Legislation based on these principles will not only secure the positive benefits of immediate utilization, but will also avoid the evils of speculative holdings of lands by fictitious use or by admitted nonuse for the future enjoyment of the unearned increment or of the profits of monopolization. With actual development made a condition of possession, and with land classification and separation of estates made preliminaries of disposition, the present-day utilization by individuals or corporations and the reservation to the people for future use become at once possible without conflict of interests.

The classification of the public land is essential to the administration of not only such laws as express the principle of separation, but also of those whose purpose is to promote the highest use of the land. Land classification is first of all the determination of the best use to which each particular portion of the public domain can be put, and by the organic act of March 3, 1879, this duty was specifically imposed upon the Director of the Geological Survey. The progress now being made in this work is set forth in another part of this report. (See pp. 60-74.)

Separation of surface and mineral rights might be effected without classification of land by the automatic reservation of all mineral deposits to the United States in every patent issued as a result of nonmineral entry, selection, or purchase. Legislation of this type would possess the merit of simplicity and effectiveness, but the well-known objection to limited patents would with considerable reason be made the basis for the contention that the Government should assume the burden of classifying its land before disposition.

The classification of the public domain is itself an outgrowth of the principle of relative worth, which early found expression in the land laws of this country, in that they provided for the reservation of mineral lands from disposition for other purposes. The present coal-land law also expresses this principle of relative worth by giving deposits of gold, silver, and copper priority over coal, and coal, in turn, preference over agricultural values. Such distinctions necessitate land classification based on adequate field examination, and with the classification data at hand the principle of relative worth can be further developed. Wherever the different values of

the land conflict the highest use should prevail, and under legislation that does not oppose the principles of economic law the highest use will prevail.

Under the withdrawal act of June 25, 1910 (Stat. L., vol. 36, p. 847), classification is made possible in advance of disposition, and disposition can be postponed to await immediate legislation. Fully to accomplish this purpose, for which it was enacted, the withdrawal act itself needs amendment in several particulars. No withdrawal is effective against location or appropriation for minerals other than coal, oil, gas, and phosphate, the apparent intent of the law being to promote the exploration and discovery of metalliferous minerals. However, this exception to the application of the withdrawal law is far too broad, in that it would include such minerals as potash or nitrates, the disposition of which is a matter of no less vital concern to the agricultural interests of the nation than is the proper utilization of the phosphate deposits. So, too, it is true that attempts are being made to claim sand and gravel as minerals excepted by the law and under such contention to secure control of power sites, even in the face of an executive withdrawal. Connected with this defect in the law is the lack of recognition therein of the principle of relative worth. There is a too evident opportunity for a gypsum entryman, notwithstanding the fact that the gypsum, by reason of poor quality or lack of transportation facilities, may be worthless commercially, to set up a claim for title to a tract of great prospective value for oil—a tract which is protected from oil entry by an oil withdrawal. Similarly, under the mineral law it is possible to seek title to the walls of a narrow canyon, withdrawn as a power site, in spite of the great discrepancy between the utterly negligible value of the building stone it contains and the strategic importance of the dam site.

#### SEPARATION OF SURFACE AND MINERAL RIGHTS.

The first step, both in principle and practice, in any amendment of the land laws, appears to be that of making possible by legislation the separation of surface and mineral rights whenever the two estates have values which can be separately utilized. A notable advance in public-land legislation was the passage of the acts of March 3, 1909 (Stat. L., vol. 35, p. 844), and June 22, 1910 (Stat. L., vol. 36, p. 583), which provide that patents issued thereunder grant title to the surface of the land only and thus permit its agricultural development, while at the same time the United States retains title to the underlying coal deposits. The results have been of undoubted value in permitting homestead and desert-land entries, Carey Act selections, and reclamation-act withdrawals on lands which are withdrawn or classified as coal lands or are known to be valuable for coal.

A similar separation of surface and mineral rights should be extended to all other nonmineral entries, selections, or locations, to include oil, gas, and phosphate lands as well as coal lands, the mineral rights to be reserved to the United States until they can be disposed of most beneficially to the people. For all these lands the need of legislation for the separation indicated is not academic but actual, since under each class there are already requests for surface patents.

Similar legislation applying the principle of separation is demanded in order to reserve to the Government the exclusive right to grant easements for the future development of water resources, for either power or irrigation, and at the same time to make provision for grants of surface patents for the agricultural use of the land, or of mineral patents where mining may not interfere with water-power development. During the last year the principle involved in this proposed legislation was recognized by the enactment of an item in the Indian appropriation act which provides for the issuance of limited patents on the shores of Flathead Lake, in Montana, where increased storage for power and irrigation may be at some future time found to be advantageous. A further recognition of this principle was given in the water-power bill introduced by Representative Parsons at the third session of the Sixty-first Congress (H. R. 33000), wherein provision is made for a double use of land leased for water-power utilization and for the reservation in perpetuity to the United States of all rights to future occupancy and use for water-power development on all lands designated by the President. The need of statutory authority for limited patents is most evident in regions where, because of the possibility of future power development, lands are now withdrawn which possess present value for agricultural use. Provision should be made whereby future power development will be absolutely insured whenever the value of the lands for such use would exceed their actual agricultural value.

The chief advantage of land withdrawal and classification lies in its essential relation to the principle of proper disposition of the public domain, the real purpose of public-land administration being to insure such reservation or disposal of the people's land as will result in its highest use. The question of amendment of the present laws relating to the disposition of coal, oil, gas, and phosphate deposits on the public domain is recognized as fairly before the public by the specific mention of these minerals in the withdrawal act.

#### LAW APPLICABLE TO COAL LANDS.

The coal-land law is unquestionably the most satisfactory of the present mineral-land laws in that it admits of the placing of an adequate valuation upon the deposits, and in the administration of this law the purpose is not only to base the appraisal price upon

the quantity and quality of the coal present and to give consideration to every known physical and commercial factor affecting the value of the deposits, but also to make the selling price approach as nearly as possible the present purchase price of a royalty under a leasehold. Thereby it is intended to permit purchase for immediate development and at the same time to prevent, or at least discourage, purchase for long-time investment or for monopolization. So many factors, however, require consideration that an ideal adjustment of the values is well-nigh unattainable for many, if not for most, coal lands, and on this account a strong argument may be made for support of the lease over the sale system. Under leasehold it would be comparatively easy so to adjust the relationship between ground rental and royalty as to prevent the acquisition of coal deposits until such time as their development should be profitable. On the other hand, it is possible, under the present law, and it is the policy in its administration, to readjust the prices from time to time, either by reduction to encourage development in special cases or, more commonly, by raising the price on account of increased value due to new discoveries or to changed commercial conditions. The greatest advantage of the lease system to the operator directly, and to the public indirectly, is relief from the large capital outlay now required in the acquisition of the large acreage absolutely necessary for a modern mine. This argument advanced against the present policy of valuing the public coal lands at even conservative prices thus becomes an argument for a leasehold law. Thus contrasting the lease with sale outright to the coal operator, the reduction in capital necessary for original investment and the elimination of many of the risks in such investment must result in reducing the cost of operation to the mine owner and thus make possible a correspondingly lower price of coal to the consumer. Hardly less important, moreover is the better control possible under a lease system, although against the advantage of such control must be weighed the cost of Federal management and the possibilities of inefficient administration or even maladministration.

The present coal-land law, however, has one serious defect, which should be remedied if a leasing law is not enacted. The restriction of area that may legally be acquired to a maximum of 160 acres for an individual and 640 acres for an association is not in accord with good mining practice. The fixed charges on the cost of a modern coal mine, provided with the up-to-date equipment necessary to conserve life and property and to assure maximum recovery, are too high to be assessed against the output of so small a tract, especially if the coal seam is of only moderate thickness. A law designed to promote the practical utilization of coal deposits, whether the system contemplates sale or lease, must provide for



the holding of a large enough unit to permit the opening and equipment of a modern mine and to warrant its economical operation. Without such provision for commercial operation too great an advantage is given to the land-grant railroads and large coal companies already in possession of considerable areas of high-grade coal.

#### LAWS APPLIED TO PHOSPHATE LANDS.

The present uncertainty whether the phosphate rock of the public land should be entered under the lode law or under the placer law is conclusive evidence of the need of legislation. As a matter of fact neither of these laws is more applicable to the acquisition of beds of phosphate-bearing limestone than it would be to that of coal beds. The realization that the phosphate deposits are more extensive than was known or suspected when the Survey geologists began land classification work in Idaho and Wyoming does not lessen but rather increases the urgency for a leasing law which will provide for the utilization of this large supply of mineral fertilizer, so as to meet both present and future needs.

#### LAW NEEDED FOR OIL AND GAS LANDS.

The most urgent need of legislation for the disposition of mineral deposits is in the case of oil and gas. It is most apparent that the placer law, which is none too well adapted to meet modern conditions in mining placer gold, is wholly inadequate if applied to public oil lands, inasmuch as oil is discovered at a late stage in the exploration and development of the land claimed under the law. Thus, large expenditures, extending over several months, if not years, are necessary before any right is acquired against the Government, and during all this time there is no legal protection of the oil prospector against unscrupulous claimants or competitors better backed by capital. The need for remedial oil legislation is somewhat less pressing than it was a year ago, by reason of the passage of the act approved March 2, 1911 (Stat. L., vol. 36, p. 1015), the effect of which is to validate a class of claims that, although clouded by the construction which the department was forced to place upon the misfit placer law under which title to oil lands must now be gained, were bona fide in that the inception of their development antedated the oil-land withdrawals. This legislation was in accord with the spirit of the withdrawal act, which provides for the protection of equities already established. The need for a better law is, however, imperative, and the legislative action demanded by the situation should not be limited to an attempt to revamp the general placer law, but should consist of the enactment of an altogether new measure, especially adapted to provide for the sane and equitable development of this industry in the future. First,

the new law should authorize the issue of exploratory permits, granting to individuals or associations the exclusive privilege of occupation, the sole condition of such a grant being diligent and adequate prosecution of development work, measured by the expenditure of fixed sums within certain periods, with possibly the payment of a small fee to the Government in lieu of such expenditure during the first six months. The issue of this permit should preferably be limited to one to each citizen or association of citizens, although after the lapse or surrender of such a permit the former holder should be allowed to apply for another exploratory permit. In the second place, the law should provide that upon discovery the holder of the permit be given a leasehold title with a royalty varied to meet local and actual conditions. The "wildcatter" or prospector in unproved country, whether such unproved territory is classified on geologic evidence as oil land or not, should be given special privilege to offset his greater risk. This privilege might take the form of an increased acreage, held both under permit and under lease, or a practical exemption from the payment of royalty, merely a nominal rental being charged under the lease. The chief advantage of the leasehold for oil over a fee-simple title lies in the prevention of monopolization through large holdings. Such large holdings without production would be guarded against by a ground rental sufficiently high to discourage the acquisition of lands except for immediate and continued development, although provision should also be made in the lease for surrender under terms which would protect the Government. This indirect control of development would be preferable to the direct enforcement, by forfeiture, of continuous production, which should be avoided because of the danger of disturbing the delicate equilibrium between supply and demand. Transfers of interest, under either permit or lease, should be permitted because of the absolute necessity in most instances of procuring capital for both drilling and operating an oil well. The law, however, should set forth the purpose of the control of such transfer, which would be to provide protection for the original locators, most of them men of small means, and more especially to insure the prohibition of too large holdings of Government leases by big companies.

#### LAWS RELATING TO METALLIFEROUS MINERALS.

Proposed amendments of the well-established laws relating to metalliferous minerals always raise the warmest discussion. With the opinion of mining men in general favoring revision of mining laws of the United States and with commission after commission appointed by various bodies to suggest improvements, the statutes have remained practically unchanged for nearly 40 years, while the



geology of ore deposits and the technology of metal mining have made marvelous progress.

The law of the apex has proved more productive of expensive litigation than of economical mining. In many of the more recently established and more progressive mining districts this statute has been made inoperative either by common agreement or by compromise between adjoining owners. Its repeal could not affect established equities under patents already granted, but would render possible more certain property rights in large mining districts, not as yet discovered, where new and valuable claims will be located a hundred years from now. The unit of disposition should be the claim, preferably square, limited on its four sides by vertical planes, and of a size sufficient to allow the miner occupying two contiguous claims to follow the vein or lode to considerable depth, even if its dip is only  $45^{\circ}$ . Such definition of a mining claim is found practicable in both Mexico and British Columbia, and in the latter country the change from the apex law was effected without trouble or confusion.

The same knowledge of natural conditions that leads to the suggestion of a repeal of the law of the apex forces the further suggestion that discovery of ore in place can not be made universally a prerequisite to the location of a mining claim. Geologic study of ore deposits has furnished examples in a number of regions where the present law can not be complied with, although rich deposits exist underground and their extent can be more definitely surmised than in most places where ore is discovered at the surface. To meet such actual conditions the law should provide for the acquisition of metaliferous mineral land classified as such upon the basis of adequate geologic evidence, whether actual outcrops are present or not.

Most important, perhaps, in any amended mining law would be provision for enforced development, a principle expressed, it is true, in the present law but not made effective in its workings. A requirement of actual use as a condition of occupancy of mineral land can not be regarded as either novel or radical. As regards the large acreage of undeveloped land in many mining camps to which patent has already been issued, it is perhaps true that the situation is without relief, unless the western Australia plan is adopted, whereby the Government steps in and permits mining under a lease, the proceeds of which are assessed, collected, and paid over to the owner. The principle invoked seems to be that no property owner can rightfully oppose the development of the resources of the State.

In the case of unpatented claims a remedy should be sought for what has been termed "the paralysis of mining districts," and the rigid requirement of annual assessment work should be made actual and effective by inspection and supervision, in order to put an end to

the present procedure of allowing a claim to lie idle for practically two years after its location, not to mention the many localities where claims are held year after year with only perfunctory compliance, or even without any performance of assessment work—a type of local disregard for law that is in striking contrast to the observance accorded to the district customs and regulations of earlier days, whereby the right of possession was made absolutely dependent upon continuous operation.

The remedy, then, for the existing evil of idle mining property must be sought either in the adoption of leasehold, under which the Government can enforce operation, a system which fully attains the desired end of promoting mining development in Australia and New Zealand, according to the report made in 1907 by Geologist Veatch, of this Survey, to the President, or in the thorough revision of the existing system. Radical amendment to the present law would be necessary in order to secure something more nearly approaching equality of opportunity. Some limitation should be put on the number of claims which an individual can locate in each mining district, and the prevention of monopolization would be furthered by the rigid enforcement of assessment development. The record of claims kept by a local official elected by the miners should be reported to the nearest land office in order to furnish the Federal Government with a notice of the intention of the claimant, and thus to initiate the operation of effective inspection, the purpose of which would be to enforce the use and development of mineral land as contemplated in the law.

#### LEGISLATION REQUIRED FOR WATER POWER.

On the subject of water-power legislation the position of the Geological Survey is essentially that set forth in January of this year in a report addressed to the Secretaries of the Interior and of Agriculture by a joint committee representing the two departments. The legislation there outlined would provide for leases of public and reserved lands of the United States valuable for water-power development for a fixed term, not to exceed 50 years, with moderate charges for use and occupancy of the land, revocable only upon breach of conditions or on account of the charge of excessive rates to consumers. These leases should be identical in terms, under whatever department they are granted, with joint and uniform regulations governing all matters relating to water-power development of land belonging to the United States. Provision should also be made for periodic and equitable readjustment of charges, transfer of leases, preferential rights to renewal, and compensation for improvements at the termination of the leasehold. The law should specifically recognize water-power use as dominant, should insure

to the lessee undisturbed occupancy of the land needed for such use, and should reserve for future utilization all land believed to possess value for water-power development, these lands to be designated by the President but to be open to other entry, subject to this reserved right wherever separation of the water-power use and other use is possible.

#### EXAMINATIONS UNDER THE WEEKS ACT.

The act approved March 1, 1911 (Stat. L., vol. 36, p. 961), which provides for the acquisition of land for the purpose of conserving the navigability of navigable streams, imposed a new duty on the Geological Survey. Section 6 of the law provides for an examination by the Geological Survey of land whose purchase is under consideration and the submission of a report based thereon to the Secretary of Agriculture, "showing that the control of such lands will promote or protect the navigation of streams on whose watersheds they lie." The law thus places upon the Geological Survey the determination of the fundamental question whether the control of the specific tract of land pertains to the promotion or protection of navigability, and stipulates that a favorable report to the Secretary of Agriculture must precede the purchase of the tract considered.

The report thus required of the Geological Survey is believed to involve something more than perfunctory action and to consist of a showing of facts rather than an expression of opinion. The solution of complex scientific problems is required in order to establish actual and substantial relationship between control of head-water tracts and the navigation of streams, and while the responsibility for this determination had not been sought by the Geological Survey, this new application of scientific investigation to an administrative problem has been accepted by the Survey as directly in line with its geologic and hydrographic work. It was at once recognized that as the determinative agent, whose favorable report must precede any action by the National Forest Reservation Commission, the Geological Survey would be exposed to criticism alike by those favoring a "broad interpretation" of both natural and statutory law and by those who had opposed the enactment of the Weeks law as embodying a subterfuge.

On the initiative of the Survey a conference was arranged between representatives of the Department of Agriculture and of the Department of the Interior, and an agreement was reached concerning procedure in the administration of this new law, so far as the Forest Service and the Geological Survey are concerned, to the end that the examinations of land by the two bureaus might be coordinated. In this agreement, which was approved by the two Secretaries on May 3, 1911, it is set forth that the examination by the Geological

Survey will include the determination of the relation of the headwater streams to the navigable streams to which they are tributary, the local observation of the headwater stream or streams draining the tract or tracts in question with reference to run-off characteristics and to nature and amount of suspended material, the classification of the surface formations of the tract with reference to permeability and storage capacity and to resistance to erosion, and the securing of such additional topographic data, in cooperation with the Forest Service, as are needed by the two bureaus in their examination of the tract.

In accordance with the terms of this agreement work was prosecuted in Georgia, Tennessee, and New Hampshire in May and June, resulting in the submission of two favorable reports to the Secretary of Agriculture before the end of the fiscal year.

Report No. 1 refers to a tract of 31,377 acres in Fannin and Union counties, Ga., and states the following general conclusions, based on local field examination, which support the proposition that the control of this tract in northern Georgia will promote and protect the navigation of Hiwassee and Tennessee rivers, in whose basins the land examined lies.

(a) Toccoa River is a headwater stream contributing a relatively large low-season flow, which makes its basin one of the class best adapted to promote the navigability of the river during the dry season.

(b) On the Gennett tract, as elsewhere in this general district, excessive soil wastage is in progress, which is chargeable to the practice of yearly burning over the forest lands, to the tillage of steep slopes, and to the presence of fallow fields.

(c) Control of these lands will to an appreciable extent insure the continuance and possible betterment of the important low-water contribution of Toccoa River and will diminish the present excessive delivery of sediment into this tributary of Hiwassee and Tennessee rivers.

The National Forest Reservation Commission, on the basis of this report and the report presented by the Forest Service, authorized the purchase of this tract.

Report No. 2 refers to a tract in Blount and Sevier counties, Tenn. This tract comprises 58,213 acres in the upper drainage basin of Little River, which enters Tennessee River below Knoxville. Little River itself is navigable in its lower part and the importance of the Tennessee as a navigable stream is well known.

The general conclusions based on the local examination and presented below support the proposition that the control of this tract will promote and protect the navigation of Little and Tennessee rivers, on whose watersheds the land examined lies. These conclusions are:

(a) Little River is a stream whose headwater branches contribute a low-season flow largely in excess of the average discharge of the Tennessee drainage basin.

(b) Excessive erosion is observed in various parts of the tract, especially in those parts which have been subject to repeated burning. A sensible reduction of the amount of sediment delivered to Little River seems possible through forest management.

Action on this report by the commission was postponed, because of questions as to terms and conditions of sale raised in the report submitted by the Forest Service.

Report No. 3, on adjoining tracts in Little River basin, aggregating 3,365 acres, based on the field examination covering the tract referred to in report No. 2, was transmitted to the Secretary of Agriculture in July.

The only topographic work thus far found necessary in these examinations has been a resurvey of the Little River drainage basin, in Tennessee. Hydrographic work in the White Mountain region was begun in May and will be continued through the summer, when the necessary geologic examination will also be made of the tracts selected by the Forest Service for proposed purchase. This plan of procedure was decided upon early in May, and the selection of tracts in the southern Appalachians for immediate examination and report before June 30 was actuated, first, by the fact that much more work had already been done in that area by the Geological Survey; second, by the fact that the geologic conditions in the region were believed to be much more favorable to the contention that an indisputable relation exists between forest lands and stream regulation, and further by the fact that the offering of two large tracts having an area of 90,000 acres in especially favorable localities, promised the maximum chance for favorable reports within a minimum time.

## NECROLOGY.

### SAMUEL FRANKLIN EMMONS.

The Geological Survey suffered an irreparable loss in the death of Samuel Franklin Emmons on March 28, 1911, after a brief illness. Mr. Emmons served the Survey as an administrative chief and a scientific leader from the first year of its history, so that mention of his attainments and his work furnishes also a record of the 32 years of achievement and progress by the organization.

Mr. Emmons was graduated from Harvard College in 1861, and after a period of study abroad joined Clarence King as an assistant in the United States Geological Exploration of the Fortieth Parallel. For nearly 10 years he remained with this organization, seeing varied service and gaining wide knowledge of the geology of the West.



With Mr. Arnold Hague he was joint author of the second volume of the great Fortieth Parallel series, entitled "Descriptive geology."

With the organization of the present Survey, in 1879, Mr. Emmons was placed by King in charge of the Rocky Mountain division, with instructions to give exclusive attention to the study of the mineral wealth, and soon thereafter he began his study of the Leadville district, then newly opened. His monograph and atlas on the "Geology and mining industry of Leadville"<sup>1</sup> were published by the Geological Survey in 1886, and at once established the reputation of their author. The Leadville report was preceded in publication by Becker's monograph on the "Geology of the Comstock lode and the Washoe district"<sup>2</sup> and by Curtis's less extensive report on the "Silver-lead deposits of Eureka, Nev.,"<sup>3</sup> but with these, and more decisively than these, it marked the beginning of a new era in economic geology and became a model for the numerous monographic reports on western mining districts that have since been published by the United States Geological Survey.

Until a few years ago Mr. Emmons continued in general charge of the investigations of western ore deposits carried on by the Survey, and many studies were planned and completed under his supervision and with his suggestive advice. In some reports he appeared as collaborator; in others his share was less patent, although perhaps scarcely less important. He was the senior author of the monograph on the "Geology of the Denver Basin" and was the sole or joint author of several folios of the Geologic Atlas of the United States. His contributions to scientific periodicals and to the transactions of societies were numerous and important. One of the most notable of these contributions was his paper on the "Secondary enrichment of ore deposits,"<sup>4</sup> which was the outcome of long-continued studies at Butte and elsewhere and which enunciated principles that were at once generally recognized as being not only of unusual scientific importance but also of great practical value.

During the later years of his life Mr. Emmons, freed from the cares of official administration, returned to his studies at Leadville, and, in association with Prof. J. D. Irving, of Yale University, was engaged in extending his earlier results in the light of additional facts brought out by extensive mining operations continued through three decades. Although some of his newer material was published in 1907 as the Survey's Bulletin 320, on the Downtown district of Leadville, Colo., Mr. Emmons did not live to see the publication of his final results. The task of completing the report has fallen to Prof. Irving.

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<sup>1</sup> Mon. U. S. Geol. Survey, vol. 12, 1886.

<sup>2</sup> Idem, vol. 3, 1882.

<sup>3</sup> Idem, vol. 7, 1884.

<sup>4</sup> Trans. Am. Inst. Min. Eng., vol. 30, 1901, pp. 177-217.

Mr. Emmons was a prominent member of many scientific societies and academies both in this country and abroad, including the National Academy of Sciences, of which he was treasurer at the time of his death. In 1903 he held the office of president of the Geological Society of America. In 1909 both Harvard and Columbia Universities conferred upon him the honorary degree of Sc. D.

The chief characteristics of his work were thorough painstaking honesty of method, wide and penetrating vision in the interpretation of his facts, remarkable soundness and stability of judgment, and clarity of exposition. Himself able to express his thought in unusually clear and felicitous language, Mr. Emmons was an invaluable critic, not only of substance but of form, and those geologists who in their younger days were so fortunate as to receive his kindly yet keen criticism have found their appreciation of what he did for them grow with the passing years and will always hold him in grateful remembrance. His own writings are an eloquent protest against the view that sound science can find appropriate expression in slovenly writing.

In the course of his long life Mr. Emmons had seen the Far West make astonishing progress, especially in the mining industry, and he had the satisfaction of knowing that by his work he had materially advanced this development. He had received unsought and bore modestly the honors that men of science most prize. His name not only stood high on the rolls of science but was known to miners throughout the Rocky Mountain region as that of the man who more than anyone else had applied geologic knowledge in a way to convince them of its value.

## WORK OF THE YEAR.

### PUBLICATIONS.

The Survey's success in reaching the public with the results of its scientific work is directly measured by the distribution of its publications. In spite of the organization of the Bureau of Mines and the consequent removal of the deservedly popular technologic bulletins from the Survey's publications, the total number of reports and maps distributed by the Geological Survey in 1911 was 1,208,797, an increase of 6 per cent over the corresponding figures for 1910. An even larger percentage of increase is shown in the number of letters received containing remittances for sale publications, while the receipts for topographic maps increased about 10 per cent. The total distribution of topographic maps, which includes congressional distribution, exchanges, and issue for departmental use, as well as the half million maps sold, exhibits the gratifying increase of 15 per cent. The total distribution to the public of books and maps is equivalent



to more than 99 per cent of the number of copies received during the year from the Government Printing Office and the Survey's engraving and printing division.

The notable increase in the amount of editorial work also furnishes a gratifying item in the year's record. The number of manuscript pages read in 1911 exceeds the largest number read in any previous year by nearly 10 per cent and exceeds the work of some recent years by 100 per cent. In pages of final proof read and indexed this year's record has been exceeded by only two years, and this excess is in part apparent rather than real, by reason of changes in measure of page and size of type, while the cost of editorial work has been much less than in other years in which a comparable amount of work was performed.

The publications of the last fiscal year are briefly described in the following summaries:

**Thirty-first Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior for the fiscal year ended June 30, 1910.**

A report on special features of the Survey's work, brief abstracts of publications of the year, and a summary of the work by branches and divisions, with maps showing the progress of topographic and areal surveys.

**Professional Paper 68. The ore deposits of New Mexico, by Waldemar Lindgren, Louis C. Graton, and Charles H. Gordon. 1910. 361 pp., 22 pls., 33 text figures.**

A detailed description of the commercially valuable ore deposits and an exhaustive exposition of the general features of the geology of the region, especially those related to the origin and occurrence of ores of metallic minerals, with descriptions of mines and prospects by counties and statistics of mineral production. Numerous maps and diagrams show the surface contour, the locations of particular mining districts, and the plans of workings of particular mines. Several plates show the appearance of typical minerals of the region in natural colors.

**Professional Paper 72. Denudation and erosion in the southern Appalachian region and the Monongahela Basin, by Leonidas Chalmers Glenn. 1911. 137 pp., 21 pls., and 1 text figure.**

A report on the nature, effects, and remedies of erosion in general, with a detailed account of special conditions in the region under discussion. The relations of such industries as agriculture, lumbering, mining, and power development to erosion are considered, and suggestions for improving conditions in the region are given. The effects of erosion are shown by numerous illustrations, and several photographs are introduced to indicate methods of regulating stream flow that have proved adaptable to particular conditions.

**Bulletin 381. Contributions to economic geology, 1908—Part II, Mineral fuels. Marius R. Campbell, geologist in charge. 1910. 559 pp., 24 pls., 15 text figures.**

A bulletin consisting of 27 short papers and preliminary reports on investigations, made in 1908, of deposits of coal, lignite, natural gas, and petroleum, including descriptions of mining districts, accounts of development work in particular localities, and results of the investigation of the character

of certain mineral fuels. The illustrations are mostly maps of coal fields and sections of mines. The bulletin includes a list of other publications of the survey on petroleum and natural gas. The bulletin includes papers having the following titles:

Stratigraphy and coal beds of the Indiana coal field, by G. H. Ashley.

The Washburn lignite field, North Dakota, by C. D. Smith.

The Fort Berthold Indian Reservation lignite field, North Dakota, by C. D. Smith.

The Fort Peck Indian Reservation lignite field, Montana, by C. D. Smith.

The central part of the Bull Mountain coal field, Montana, by R. W. Richards.

The Milk River coal field, Montana, by L. J. Pepperberg.

Notes on the coals of the Custer National Forest, Montana, by C. H. Wegemann.

The Powder River coal field, Wyoming, adjacent to the Burlington Railroad, by R. W. Stone and C. T. Lupton.

The Buffalo coal field, Wyoming, by H. S. Gale and C. H. Wegemann.

The coal field in the southeastern part of the Bighorn Basin, Wyoming, by E. G. Woodruff.

The eastern part of the Little Snake River coal field, Wyoming, by M. W. Ball and Eugene Stebinger.

The southern part of the Rock Springs coal field, Sweetwater County., Wyo., by A. R. Schultz.

Weathering of coal in the arid region of the Green River Basin, Sweetwater County, Wyo., by A. R. Schultz.

Coal of the Denver Basin, Colorado, by G. C. Martin.

The South Park coal field, Colorado, by C. W. Washburne.

The Colorado Springs coal field, Colorado, by M. I. Goldman.

The Canon City coal field, Colorado, by C. W. Washburne.

The Trinidad coal field, Colorado, by G. B. Richardson.

Isolated coal fields in Santa Fe and San Miguel counties, New Mexico, by J. H. Gardner.

The Carthage coal field, New Mexico, by J. H. Gardner.

The coal field between San Mateo and Cuba, New Mexico, by J. H. Gardner.

Geology and oil prospects of the Reno region, Nevada, by Robert Anderson.

Two areas of oil prospecting in Lyon County, western Nevada, by Robert Anderson.

Analysis of crude petroleum from Oklahoma and Kansas, by D. T. Day.

The Madill oil pool, Oklahoma, by J. A. Taff and W. J. Reed.

Development in the Boulder oil field, Colorado, by C. W. Washburne.

The Florence oil field, Colorado, by C. W. Washburne.

Survey publications on petroleum and natural gas.

Bulletin 425. The explosibility of coal dust, by George S. Rice, with chapters by J. C. W. Frazer, Axel Larsen, Frank Haas, and Carl Scholz. 1910. 186 pp., 14 pls., 28 text figures.

A summary of experiments and mine investigations showing the explosibility of coal dust and the available protective measures. A history of the discussion of coal-dust explosions is given and also a brief account of recent disasters. The origin of coal dust, its distribution and ignition, and the possible means of preventing the dangers it presents are considered in the light of the results of recent experiments made in America and in Europe. The value of exhaust steam to prevent the formation of coal dust is treated at length.

**Bulletin 426.** Granites of the southeastern Atlantic States, by Thomas Leonard Watson. 1910. 282 pp., 27 pls., 22 text figures.

A report on the commercial granites of Maryland, Virginia, Georgia, Alabama, Tennessee, North Carolina, and South Carolina. The introductory chapter includes a discussion of the mineral and chemical composition, the physical properties, and the geologic characteristics of granites in general. Under the headings of the States named the distribution of granites in the region is considered and the features of local varieties are described.

**Bulletin 427.** Manganese deposits of the United States, with sections on foreign deposits, chemistry, and uses, by Edmund Cecil Harder. 1910. 298 pp., 2 pls., 33 text figures.

Detailed descriptions of the deposits of manganese ores in the United States, with chapters on the sources of the metal, the production of manganese in foreign countries, its chemical compounds and alloys, its uses in metallurgy, chemistry, and as a coloring material, and the status of manganese production in the United States.

**Bulletin 429.** Oil and gas in Louisiana, with a brief summary of their occurrence in adjacent States, by G. D. Harris. 1910. 192 pp., 22 pls., 21 text figures.

Outlines the modes of occurrence and methods of exploitation of oil and gas in Louisiana. Saline-dome oil and gas and stratum oil and gas are considered separately, the numerous prospects and producing fields are described, and the condition of development work is reported.

**Bulletin 430.** Contributions to economic geology (short papers and preliminary reports), 1909—Part I, Metals and nonmetals except fuels. C. W. Hayes and Waldemar Lindgren, geologists in charge. 1910. 653 pp., 14 pls., 75 text figures.

Includes 42 short papers or preliminary reports on investigations made in 1909 of deposits of gold, silver, copper, lead, and other minerals. Some newly developed deposits are described and the results of special investigations of particular mineral fields are reported. In addition to chapters on the more common metallic substances, contains chapters on aluminum ores, asphaltum, structural materials, abrasives, mineral paints, salines, phosphates, sulphur and pyrite, and the rare metals. A complete list of the papers included in the report follows:

Notes on the placer deposits of Greaterville, Ariz., by J. M. Hill.

Gold mining in the Randsburg quadrangle, California, by F. L. Hess.

The Weaverville-Trinity Center gold gravels, Trinity County, Cal., by D. F. MacDonald.

Placer gravels of the Sumpter and Granite districts, eastern Oregon, by J. T. Pardee.

Survey publications on gold and silver.

The occurrence of copper in Shasta County, Cal., by L. C. Graton.

Geology of the copper deposits near Montpelier, Bear Lake County, Idaho, by H. S. Gale.

The copper deposits of South Mountain in southern Pennsylvania, by G. W. Stose.

Survey publications on copper.

Notes on the mineral deposits of the Bearpaw Mountains, Montana, by L. J. Pepperberg.

Survey publications on lead and zinc.

- Notes on the occurrence of cinnabar in central western Arizona, by Howland Bancroft.
- Some occurrences of molybdenite in the Santa Rita and Patagonia mountains, Arizona, by F. C. Schrader and J. M. Hill.
- Note on the occurrence of tungsten minerals near Calabasas, Ariz., by J. M. Hill.
- Some chromite deposits in western and central California, by E. C. Harder.
- An occurrence of monazite in northern Idaho, by F. C. Schrader.
- Platinum in southeastern Nevada, by Howland Bancroft.
- The Virginia rutile deposits, by T. L. Watson and Stephen Taber.
- Notes on tungsten deposits near Deer Park, Wash., by Howland Bancroft.
- Survey publications on antimony, chromium, nickel, platinum, quicksilver, tin, tungsten, uranium, vanadium, etc.
- Some iron ores of western and central California, by E. C. Harder.
- The Iron Age iron-ore deposit, near Dale, San Bernardino County, Cal., by E. C. Harder and J. L. Rich.
- Iron ores near Dayton, Nev., by E. C. Harder.
- The Jauss iron mine, Dillsburg, Pa., by A. C. Spencer.
- Deposits of brown iron ore near Dillsburg, York County, Pa., by E. C. Harder.
- Preliminary report on pre-Cambrian geology and iron ores of Llano County, Tex., by Sidney Paige.
- Survey publications on iron and manganese ores.
- Survey publications on aluminum ores.
- Survey publications on asphalt.
- Field investigations of structural materials, by E. F. Burchard.
- Structural materials available in the vicinity of Minneapolis, Minn., by E. F. Burchard.
- Structural materials available in the vicinity of Austin, Tex., by E. F. Burchard.
- The slates of Arkansas, by A. H. Purdue.
- The oolitic limestone industry at Bedford and Bloomington, Ind., by J. A. Udden.
- Supplementary notes on the granites of New Hampshire, by T. N. Dale.
- Oolitic limestone at Bowling Green and other places in Kentucky, by J. H. Gardner.
- Survey publications on building stone and road metal.
- Cement materials in Republican Valley, Nebraska, by N. H. Darton.
- Gravel and sand in the Pittsburg district, Pennsylvania, by E. W. Shaw.
- Survey publications on cement and cement and concrete materials.
- Fuller's earth and brick clays near Clinton, Mass., by W. C. Alden.
- Survey publications on clays, fuller's earth, etc.
- The gypsum deposits of the Palen Mountains, Riverside County, Cal., by E. C. Harder.
- Gypsum deposits near Cane Springs, Kern County, Cal., by F. L. Hess.
- Survey publications on gypsum and plasters.
- Survey publications on lime and magnesite.
- Survey publications on glass sand and glass-making materials.
- Survey publications on abrasive materials.
- Ocher deposits of eastern Pennsylvania, by J. C. Stoddard and A. C. Callen.
- Paint-ore deposits near Lehigh Gap, Pennsylvania, by F. T. Agthe and J. L. Dynan.

Survey publications on mineral paints.

Preliminary report on the phosphate deposits in southeastern Idaho and adjacent parts of Wyoming and Utah, by H. S. Gale and R. W. Richards.

Phosphate deposits east of Ogden, Utah, by Elliot Blackwelder.

Survey publications on phosphates and other mineral fertilizers.

The salt resources of the Idaho-Wyoming border, with notes on the geology, by C. L. Breger.

Deposits of sodium salts in Wyoming, by A. R. Schultz.

Survey publications on salines, including salt, borax, and soda.

Survey publications on sulphur and pyrite.

Mica deposits of North Carolina, by D. B. Sterrett.

Supposed graphite deposits near Brigham, Utah, by H. S. Gale.

Survey publications on miscellaneous nonmetallic products.

**Bulletin 431.** Contributions to economic geology (short papers and preliminary reports), 1909—Part II, Mineral fuels. M. R. Campbell, geologist in charge. 1911. 254 pp., 12 pls., 4 text figures.

An introduction by Mr. Campbell gives a list of coal and oil fields examined in 1909 concerning which reports are being prepared for publication by the Survey. The body of the volume comprises the following papers:

Natural gas in North Dakota, by A. G. Leonard.

The San Juan oil field, San Juan County, Utah, by H. E. Gregory.

Gas and oil prospects near Vale, Oreg., and Payette, Idaho, by C. W. Washburne.

Gas prospects in Harney Valley, Oregon, by C. W. Washburne.

Preliminary report on the geology and oil prospects of the Cantua-Panoche region, California, by Robert Anderson.

The southern part of the Cahaba coal field, Alabama, by Charles Butts.

The Powell Mountain coal field, Scott and Wise counties, Va., by M. R. Campbell and E. G. Woodruff.

The eastern part of the Bull Mountain coal field, Montana, by C. T. Lupton.

Preliminary report on the Coos Bay coal field, Oregon, by J. S. Diller and M. A. Fishel.

The Black Mesa coal field, Arizona, by M. R. Campbell and H. E. Gregory.

Coal deposits near Pinedale, Navajo County, Ariz., by A. C. Veatch.

Coal in San Benito County, Cal., by M. R. Campbell.

**Bulletin 432.** Some ore deposits in Maine and the Milan mine, New Hampshire, by William H. Emmons. 1910. 62 pp., 3 pls., 23 text figures.

An account of the geology and ore deposits of Maine, with detailed descriptions of the mines and consideration of their commercial value. The area covered by the report includes Hancock, Somerset, Washington, and Oxford counties, Maine, and the Milan mine in New Hampshire.

**Bulletin 433.** Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska, by Philip S. Smith. 1910. 234 pp., 16 pls., 26 text figures.

An account of the geology and geography of Seward Peninsula, particularly of the Solomon and Casadepaga quadrangles, with a statement of present economic development in those quadrangles. The work of Mr. Smith establishes the geologic relations of the rocks of the district to the rest of Seward Peninsula and shows that their structure is very complex. Large-scale geologic and topographic maps, in colors, accompany the report.

**Bulletin 434.** Results of spirit leveling in Delaware, District of Columbia, Maryland, and Virginia, 1896 to 1909. R. B. Marshall, chief geographer. 1910. 74 pp.

Gives the elevation above sea level of about 600 points in the area considered, arranged by quadrangles. The work in Maryland and that in Virginia during a part of the year 1908 was done in cooperation with the States.

**Bulletin 435.** A reconnaissance of parts of northwestern New Mexico and northern Arizona, by N. H. Darton. 1910. 88 pp., 17 pls., 8 text figures.

A detailed description of the geology of the Rio Grande Valley and the Grand Canyon of the Colorado region, undertaken to determine the prospects for obtaining deep-seated underground water supplies. The peculiar formations of the Grand Canyon are described, the mineral resources of the region are considered briefly, and numerous well records are given.

**Bulletin 436.** The fauna of the phosphate beds of the Park City formation in Idaho, Wyoming, and Utah, by George H. Girty. 82 pp., 7 pls.

Descriptions of invertebrate fossils found in the phosphate beds near Park City, Utah, with illustrations showing the forms discovered.

**Bulletin 437.** Results of spirit leveling in Maine, New Hampshire, and Vermont, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 59 pp. 1910.

Gives elevations of about 500 points, arranged by quadrangles. The work in Maine was done in cooperation with the State from 1899 to 1909, inclusive.

**Bulletin 438.** Geology and mineral resources of the St. Louis quadrangle, Missouri-Illinois, by N. M. Fenneman. 1911. 73 pp., 6 pls., 1 text figure.

A brief geologic history of the district and descriptions of its topography, stratigraphy, and mineral resources. Contains a geologic map of the quadrangle and illustrations showing the structure and some other geologic features. The coal, clay, quarry rock, oil, gas, sand, gravel, and water resources of the quadrangle are described in connection with its economic geology.

**Bulletin 439.** The fauna of the Morefield shale of Arkansas, by George H. Girty. 1911. 148 pp., 15 pls.

Descriptions of invertebrate fossils of an important section of Mississippian rocks. The species are considered individually and in detail, and most of the forms are illustrated in the plates.

**Bulletin 440.** Results of triangulation and primary traverse for the years 1906, 1907, and 1908. R. B. Marshall, chief geographer. 1910. 668 pp., 1 pl.

Gives the results of triangulation and primary traverse in the United States from 1906 to 1908, inclusive, listing 716 triangulation stations and 6,243 primary traverse stations, nearly all on United States standard datum. The bulletin includes a map showing the condition of astronomic location and primary control to January 1, 1909.

**Bulletin 441.** Results of spirit leveling in Alabama, Georgia, North Carolina, South Carolina, and Tennessee, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 145 pp.

Gives the elevations of about 1,300 points in the States named. The report includes all leveling by the Geological Survey in this area, arranged by quadrangles. The work in Alabama from 1899 to 1905 and in North Carolina in 1896 and from 1902 to 1909 was done in cooperation with those States.



**Bulletin 442. Mineral resources of Alaska—report on progress of investigations in 1909, by Alfred H. Brooks and others. 1910. 432 pp., 8 pls., 8 text figures.**

An annual report on the work of the Geological Survey in Alaska. Includes, in addition to an administrative report, a large number of special reports on various features of the work, among which are papers on the mining industry in 1909, the utilization of Alaskan coal, the preparation and use of peat as a fuel, and the auriferous quartz veins of the Fairbanks district. The report includes papers having the following titles:

Administrative report, by Alfred H. Brooks.

The mining industry in 1909, by Alfred H. Brooks.

Alaska coal and its utilization, by Alfred H. Brooks.

The preparation and use of peat as a fuel, by Charles A. Davis.

Mining in southeastern Alaska, by Adolph Knopf.

Occurrence of iron ore near Haines, by Adolph Knopf.

Report of water-power reconnaissance in southeastern Alaska, by John C. Hoyt.

Mining in the Chitina district, by Fred H. Moffit.

Mining and prospecting on Prince William Sound in 1909, by U. S. Grant.

Preliminary report on the mineral resources of the southern part of Kenai Peninsula, by U. S. Grant and D. F. Higgins.

Outline of the geology and mineral resources of the Iliamna and Clark lakes region, by G. C. Martin and F. J. Katz.

Gold placers of the Mulchatna, by F. J. Katz.

Sketch of the geology of the northeastern part of the Fairbanks quadrangle, by L. M. Prindle.

The auriferous quartz veins of the Fairbanks district, by L. M. Prindle.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth.

Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, by Bertrand L. Johnson.

Water supply of the Yukon-Tanana region, 1909, by C. E. Ellsworth.

The Koyukuk-Chandalar gold region, by A. G. Maddren.

Mineral resources of the Nulato-Council region, by Philip S. Smith and Henry M. Eakin.

Mining in Seward Peninsula, by Fred F. Henshaw.

Water-supply investigations in Seward Peninsula in 1909, by Fred F. Henshaw.

**Bulletin 443. Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins. 1910. 89 pp., 12 pls., 9 text figures.**

Contains detailed descriptions of the many copper mines and prospects of the district and notes on the occurrence of gold and other metals of commercial importance. The topography and general geology of the region are fully considered and the report is accompanied by a large-scale geologic map.

**Bulletin 444. Bibliography of North American geology for 1909, with subject index, by John M. Nickles. 1910. 174 pp.**

A list, arranged alphabetically by authors' names, of publications bearing on the geology of North America, the adjoining islands, Panama, and the Hawaiian Islands, with summaries of many of the publications. The work is indexed and includes lists of chemical analyses and of minerals, rocks, and geologic formations described.

**Bulletin 445.** Geology of the pegmatites and associated rocks of Maine, including feldspar, quartz, mica, and gem deposits, by Edson S. Bastin. 1911. 152 pp., 19 pls., 8 text figures.

Describes in detail the general geology and the specific occurrence of pegmatites in Maine and the relations of granites and pegmatites, and discusses at length the economically important pegmatite minerals, in respect to their occurrence, uses, production, and prices. Among these minerals are feldspar, quartz, mica, tourmaline, and beryl.

**Bulletin 446.** Geology of the Berners Bay region, Alaska, by Adolph Knopf. 1911. 58 pp., 2 pls., 4 text figures.

A report on the geology and ore deposits of the Berners Bay region, at the northwest extremity of the Juneau gold belt, describing the mines and prospects of the region and the mineralogy of the ore deposits. Mr. Knopf's report shows that the mineralization of south-central Alaska was synchronous with that of the Mother Lode district in California.

**Bulletin 447.** Mineral resources of Johnstown, Pa., and vicinity, by W. C. Phalen and Lawrence Martin. 1911. 142 pp., 7 pls., 22 text figures.

A full discussion of the geology of this important coal-bearing region, with descriptions of its mineral resources. Coal and clay, the most valuable resources, are treated in detail by districts, and many analyses of coal and clay from particular districts are given. The occurrence of glass sand, building stone, lime, cement, and iron ores is also discussed.

**Bulletin 449.** A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska, by P. S. Smith and H. M. Eakin. 1911. 146 pp., 13 pls.

A report on the geography, geology, climate, vegetation, and mineral resources of a hitherto unexplored district. Illustrated by maps and half-tone plates. The gold placers and lode prospects of the region are described in detail, and the coal exposures are also considered.

**Bulletin 452.** The Lander and Salt Creek oil fields, Wyoming: The Lander oil field, Fremont County, by E. G. Woodruff; The Salt Creek oil field, Natrona County, by C. H. Wegemann. 1911. 87 pp., 12 pls., 1 text figure.

Descriptions of the stratigraphy and structure of the two fields and full accounts of the oil origin, condition of development, and available markets, with large-scale maps of the oil fields.

**Bulletin 453.** Results of spirit leveling in Minnesota, 1897 to 1910, inclusive. R. B. Marshall, chief geographer. 1911. 39 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 600 places. The work in 1909 and 1910 was done in cooperation with the State of Minnesota. This and similar bulletins contain a half-tone illustration showing designs for bench marks used by the United States Geological Survey, and all elevations are arranged by quadrangles.

**Bulletin 457.** Results of spirit leveling in the State of Washington, 1896 to 1910, inclusive. R. B. Marshall, chief geographer. 1911. 108 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 1,800 places. The work in 1909 and 1910 was done in cooperation with the State of Washington.



Bulletin 459. Results of spirit leveling in Missouri, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 48 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 450 places. The work from 1907 to 1909, inclusive, was done in cooperation with the State.

Bulletin 460. Results of spirit leveling in Iowa, 1896 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 32 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 250 places. The work from 1907 to 1909, inclusive, was done in cooperation with the State.

Bulletin 461. Results of spirit leveling in Michigan and Wisconsin, 1897 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 64 pp., 1 pl.

A report on precise and primary leveling in the two States, showing the altitudes above sea level of more than 550 places. The work from 1901 to 1909, inclusive, was done in cooperation with the States.

Bulletin 462. Results of spirit leveling in Oregon, 1896 to 1910, inclusive. R. B. Marshall, chief geographer. 1911. 82 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 750 places. The work from 1905 to 1910, inclusive, was done in cooperation with the State.

Bulletin 463. Results of spirit leveling in Arizona, 1899 to 1909, inclusive. R. B. Marshall, chief geographer. 1911. 94 pp., 1 pl.

A report on precise and primary leveling in the State, showing the altitudes above sea level of more than 800 places.

Bulletin 465. The State geological surveys of the United States, compiled under the direction of C. W. Hayes. 1911. 177 pp.

Brief sketches of the origin and history of the geological surveys in the several States and Territories of the United States, their organization, and the laws governing them, with statements showing the amounts appropriated and the purposes for which they have been expended. Compiled from reports submitted by the State geologists or by other officials of the surveys.

Advance chapters from Bulletin 470, "Contributions to economic geology (short papers and preliminary reports), 1910—Part I, Metals and nonmetals except fuels," as follows:

Bulletin 470-A. Phosphates in Montana, by Hoyt S. Gale. 1911. 7 pp., 2 text figures.

A report on the location and structure of phosphate deposits at Melrose, Mont., with reference to their value and accessibility.

Bulletin 470-D. Lead and zinc, by R. W. Richards and Howland Bancroft. 1911. 30 pp., 4 text figures.

Papers on the lead and zinc deposits in the Metaline mining district, Washington, and the lead and copper deposits in the Bear River Range, Idaho and Utah, with a list of Survey publications on lead and zinc.

Bulletin 470-E. Rare metals, by F. L. Hess. 1911. 12 pp., 1 text figure.

Includes a report on the arsenic deposits at Brinton, Va., and a list of Survey publications on antimony, chromium, monazite, nickel, platinum, quicksilver, tin, tungsten, uranium, and vanadium.

Bulletin 470-F. Iron and manganese, by Charles Butts. 1911. 22 pp., 4 text figures.

A report on the iron ores in the Montevallo-Columbiana region, Alabama, with sketch maps showing the location of the deposits and a list of Survey publications on iron and manganese.

**Bulletin 470—I. Mineral paints, by B. L. Miller. 1911. 15 pp.**

A paper on the paint shales of Pennsylvania and a list of Survey publications on mineral paints.

**Bulletin 470—J. Sulphur and pyrite, by R. W. Richards and J. H. Bridges. 1911. 8 pp., 1 text figure.**

A report on the sulphur deposits near Soda Springs, Idaho, and a list of Survey publications on sulphur and pyrite.

**Bulletin 470—K. Miscellaneous nonmetallic products. 1911. 45 pp., 6 text figures. Contains the following papers:**

The types, modes of occurrence, and important deposits of asbestos in the United States, by J. S. Diller.

Dolomite for flux in the vicinity of Montevallo, Shelby County, Ala., by Charles Butts.

Graphite near Dillon, Mont., by A. N. Winchell.

Fluorspar near Deming, N. Mex., by N. H. Darton and E. F. Burchard.

**Water-Supply Paper 237. The quality of the surface waters of California, by Walton Van Winkle and Frederick M. Eaton, in cooperation with the California Department of Engineering. 1910. 142 pp., 1 pl.**

A description of the drainage of the State, with analyses and assays of surface waters and general conclusions regarding the adaptability of the waters of the several streams for various uses.

**Water-Supply Paper 240. Geology and water resources of the San Luis Valley, Colorado, by C. E. Siebenthal. 1910. 128 pp., 13 pls., 15 text figures.**

A comprehensive view of the geology of the San Luis Valley and the surrounding rim, with a description of the artesian basin, its development and its prospects, and information in regard to climate, agriculture, irrigation, and water resources.

**Water-Supply Paper 246. Surface water supply of the United States, 1907–8: Part VI, Missouri River basin, prepared under the direction of M. O. Leighton by Robert Follansbee and J. E. Stewart. 1910. 311 pp., 13 pls., 2 text figures.**

**Water-Supply Paper 251. Surface water supply of the United States, 1907–8: Part XI, California, prepared under the direction of M. O. Leighton by W. B. Clapp and W. F. Martin. 1910. 363 pp., 7 pls., 1 text figure.**

Water-Supply Papers 246 and 251 contain the results of stream measurements in the United States during the calendar years 1907 and 1908, continuing the Survey's series of reports on stream gagings. These papers give gage-height records, results of current-meter measurements, rating tables, and estimates of monthly discharges at stations maintained, on many streams.

**Water-Supply Paper 253. Water powers of the Cascade Range—Part I, Southern Washington, by J. C. Stevens. 1910. 94 pp., 21 pls., 3 text figures.**

The first of a proposed series of reports dealing with the water powers on rivers flowing from the Cascade Range in Washington and Oregon. The area treated in this paper comprises the drainage basins of Klickitat, White Salmon, Little White Salmon, Lewis, and Toutle rivers and is located in the southern extremity of the Cascade Range in Washington. Descriptions of the several drainage areas are given, together with profiles of the streams and principal tributaries, discharge data, and detailed statements of the water powers capable of being developed at the average minimum stage of the streams.

**Water-Supply Paper 254.** The underground waters of north-central Indiana, by Stephen R. Capps, with a chapter on the chemical character of the waters by R. B. Dole. 1910. 279 pp., 7 pls., 12 text figures.

A report on the quantity, quality, distribution, accessibility, and proper safeguarding of the ground-water supplies of the farming districts and manufacturing centers of north-central Indiana. Conditions in 378 cities and towns were investigated in its preparation. The paper includes the results of numerous analyses and assays. The chapter by Mr. Dole considers not only the mineral composition of the waters of the region but their value for domestic and industrial uses as well. Methods of purification are also discussed.

**Water-Supply Paper 255.** Underground waters for farm use, by M. L. Fuller, 58 pp., 17 pls., 27 text figures.

A brief report discussing the sources of farm water supplies with especial reference to their protection from contamination and their conservation. Describes many kinds of wells and tells what factors should govern the selection of a certain type. Contains numerous illustrations showing water-bearing formations and methods of sinking wells and raising water, and diagrams showing different well conditions.

**Water-Supply Paper 256.** Geology and underground waters of southern Minnesota, by C. W. Hall, O. E. Meinzer, and M. L. Fuller. 1911. 406 pp., 18 pls., 9 text figures.

A sketch of the physiography and geology of the region with special reference to the water-bearing capacity of the different geologic formations, detailed descriptions by counties of the underground-water resources, and a chapter on problems relating to wells. The illustrations include maps showing underground-water conditions, geologic sections in the different counties, and diagrams of well-drilling tools.

**Water-Supply Paper 257.** Well-drilling methods, by Isaiah Bowman. 1911. 139 pp., 4 pls., 25 text figures.

Designed for the needs of drillers and others interested in the development of underground resources. Describes the occurrence of oil and gas in different parts of the United States so as to enable drillers to select well sites with a definite idea of the rock formations that may be encountered. Gives a short account of the development of well construction and describes methods of drilling and boring in detail. The illustrations include well sections and cuts of the different devices and tools employed.

**Water-Supply Paper 258.** Underground-water papers. 1910. 123 pp., 2 pls., 32 text figures.

The fifth of a series of collections of papers that give brief accounts of investigations of special underground-water problems by the United States Geological Survey. Discusses some peculiar conditions affecting the economic value of wells and the occurrence of water in certain rocks of widespread occurrence. Contains the following papers:

Drainage by wells, by M. L. Fuller.

Freezing of wells and related phenomena, by M. L. Fuller.

Occurrence and composition of well waters in the slates of Maine, by F. G. Clapp.

Occurrence and composition of well waters in the granites of New England, by F. G. Clapp.

Pollution of underground waters in limestone, by G. C. Matson.

Protection of shallow wells in sandy deposits, by M. L. Fuller.

Composition of mineral springs in Maine, by F. G. Clapp.

Saline artesian waters of the Atlantic Coastal Plain, by Samuel Sanford.

Magnetic wells, by M. L. Fuller.

The utilization of the underflow near St. Francis, Kans., by H. C. Wolff.

**Water-Supply Paper 260.** Preliminary report on the ground waters of Estancia Valley, New Mexico, by Oscar E. Meinzer. 1910. 33 pp.

A brief report summarizing the geology of the district, the character of the soils, the source, disposal, recovery, and quality of its waters, and the prospects of improving conditions by irrigation.

**Water-Supply Paper 262.** Surface water supply of the United States, 1909; Part II, South Atlantic coast and eastern Gulf of Mexico, prepared under the direction of M. O. Leighton by M. R. Hall and R. H. Bolster. 1910. 150 pp., 5 pls.

**Water-Supply Paper 263.** Surface water supply of the United States, 1909: Part III, Ohio River basin, prepared under the direction of M. O. Leighton by A. H. Horton, M. R. Hall, and R. H. Bolster. 1911. 192 pp., 6 pls.

**Water-Supply Paper 264.** Surface water supply of the United States, 1909: Part IV, St. Lawrence River basin, prepared under the direction of M. O. Leighton by C. C. Covert, A. H. Horton, and R. H. Bolster. 1911. 130 pp., 5 pls.

**Water-Supply Paper 265.** Surface water supply of the United States, 1909: Part V, Hudson Bay and upper Mississippi River basins, prepared under the direction of M. O. Leighton by Robert Follansbee, A. H. Horton, and R. H. Bolster. 1911. 231 pp., 4 pls.

**Water-Supply Paper 270.** Surface water supply of the United States, 1909: Part X, The Great Basin, prepared under the direction of M. O. Leighton by E. C. La Rue and F. F. Henshaw. 1910. 192 pp., 5 pls., 1 text figure.

Water-Supply Papers 262 to 265, inclusive, and 270 contain descriptions of the drainage basins named and the results of stream measurements in them, namely, gage-height records, results of current-meter measurements, and daily and monthly discharges. Illustrations showing typical gaging stations, current meters, and rating curves accompany each book.

**Mineral resources of the United States, calendar year 1909;** 54 advance chapters, namely:

Summary of mineral production in the United States in 1909, compiled by W. T. Thom. 59 pp.

Metals and metallic ores in 1908 and 1909, by Waldemar Lindgren. 7 pp.

Iron ore, pig iron, and steel, by E. F. Burchard. 31 pp.

Movement of Lake Superior iron ore in 1909, by John Birkinbine. 7 pp.

Contains a map showing distribution of the ores.

Manganese ore, by E. F. Burchard. 15 pp.

Gold and silver, by H. D. McCaskey. 33 pp.

Copper, by B. S. Butler. 34 pp.

Lead, by C. E. Siebenthal. 25 pp.

Zinc and cadmium, by C. E. Siebenthal. 24 pp.

Gold, silver, copper, lead, and zinc in the Western States and Territories (mine production), by A. H. Brooks, C. N. Gerry, V. C. Heikes, C. W. Henderson, H. D. McCaskey, Chester Naramore, and C. G. Yale. 275 pp.

Silver, copper, lead, and zinc in the Central States (mine production), by B. S. Butler and C. E. Siebenthal. 41 pp.

Gold, silver, copper, lead, and zinc in the Eastern States (mine production), by H. D. McCaskey. 17 pp.

Quicksilver, by H. D. McCaskey. 13 pp.

Bauxite and aluminum, by W. C. Phalen. 14 pp.

Antimony, arsenic, bismuth, and selenium, by F. L. Hess. 9 pp.

Tungsten, nickel, cobalt, vanadium, titanium, molybdenum, tantalum, uranium, and tin, by F. L. Hess. 16 pp.

Chromic iron ore, by E. F. Burchard. 5 pp.

Platinum and allied metals, by Waldemar Lindgren. 9 pp.

Coal, by E. W. Parker. 195 pp., 4 text figures.

Anthracite coal, by E. W. Parker. 12 pp.

Coal briquetting, by E. W. Parker. 17 pp.

Coke, by E. W. Parker. 57 pp.

Natural gas, by B. Hill. 36 pp.

Petroleum, by D. T. Day. 129 pp.

Petroleum operators' statistics of petroleum production, by D. T. Day. 10 pp.

Peat, by C. A. Davis. 6 pp.

Cement industry, by E. F. Burchard. 22 pp., 2 text figures.

Clay-working industries, by Jefferson Middleton. 67 pp.

Building operations, by Jefferson Middleton. 17 pp.

Glass sand, other sand, and gravel, by E. F. Burchard. 26 pp.

Sand-lime brick, by Jefferson Middleton. 7 pp.

Slate, by A. T. Coons. 14 pp.

Stone and lime, by E. F. Burchard. 51 pp.

Abrasive materials, by W. C. Phalen. 21 pp.

Fluorspar and cryolite, by E. F. Burchard. 8 pp.

Borax, by C. G. Yale. 4 pp.

Gypsum, by E. F. Burchard. 11 pp.

Lithium, by F. L. Hess. 7 pp.

Phosphate rock, by F. B. Van Horn. 7 pp.

Salt and bromine, by W. C. Phalen. 25 pp.

Sulphur and pyrite, by W. C. Phalen. 14 pp.

Barytes and strontium, by E. F. Burchard. 6 pp.

Mineral paints, by E. F. Burchard. 22 pp.

Asbestos, by J. S. Diller. 11 pp.

Asphalt, related bitumens, and bituminous rock, by D. T. Day. 5 pp.

Fuller's earth, by F. B. Van Horn. 6 pp.

Gems and precious stones, by D. B. Sterrett. 74 pp.

Graphite, by E. S. Bastin. 34 pp.

Magnesite, by C. G. Yale. 5 pp.

Mica, by D. B. Sterrett. 14 pp.

Mineral waters, by Samuel Sanford. 41 pp.

Monazite and zircon, by D. B. Sterrett. 11 pp.

Quartz and feldspar, by E. S. Bastin. 9 pp.

Talc and soapstone, by J. S. Diller. 11 pp.

Geologic Folio 172. Description and maps of the Warren quadrangle, comprising 222 square miles in Pennsylvania and New York, by Charles Butts. 1910. 11 folio pages of text, including 17 text figures, and geologic and topographic maps. Published also in octavo form, 80 pages of text, with 17 figures; maps in pocket.

**Geologic Folio 174.** Description and maps of the Johnstown quadrangle, comprising 228 square miles in Pennsylvania, by W. C. Phalen. Surveyed in cooperation with the Topographic and Geologic Commission of Pennsylvania. 1910. 15 folio pages of text, including 12 text figures, with columnar and structure section sheets and topographic and geologic maps. Published also in octavo form, 110 pages, 12 figures; maps in pocket.

**Geologic Folio 175.** Description and maps of the Birmingham quadrangle, comprising 992 miles in north-central Alabama, by Charles Butts. 1910. 24 folio pages of text, columnar and structure section sheets, geologic and topographic maps, 12 plates, 17 text figures. To be published also in octavo form.

**Geologic Folio 176.** Description and maps of the Sewickley quadrangle, comprising 227 square miles in west-central Pennsylvania, by M. J. Munn. 1911. 16 folio pages of text, a columnar-section sheet, 8 text figures, and 4 maps showing topography, geology, and occurrence of oil and gas. Published also in octavo form, 121 pages, 8 figures; maps in pocket.

**Geologic Folio 177.** Description and maps of the Burgettstown and Carnegie - quadrangles, comprising 455 square miles in Pennsylvania, by E. W. Shaw and M. J. Munn. 1911. 16 folio pages of text, columnar and well section sheets, geologic and topographic maps, and 10 text figures. To be published also in octavo form.

**Topographic maps as follows:**

Abingdon, Va.-Tenn.-N. C. <sup>1</sup>	Frisco special, Utah. <sup>1</sup>	Nicolaus, Cal.
Antelope, Cal.	Fryeburg, Me.-N. H.	Okawville, Ill.
Antrim, Ohio.	Galt, Cal.	Parker, Ariz.-Cal.
Antwerp, N. Y.	Greenwood Lake, N. J.-N. Y. <sup>1</sup>	Peytona, W. Va.
Arcade, Cal.	Hardinville, Ill.	Philo, Ohio.
Barrett, Minn.	Hawthorne, Nev.-Cal.	Pikeville special, Tenn.
Bath, N. Y.	Headreach, Cal.	Prince Frederick, Md.
Bouldin, Cal.	Hennepin, Ill. <sup>1</sup>	Princeton, Ky.
Bruceville, Cal.	Herman, Mich.	Pullman, Wash.-Idaho.
Butler, Pa.	Jersey, Cal.	Quincy, Wash.
Calumet special, Mich.	Jonestown, Miss.	Ramapo, N. Y.-N. J. <sup>1</sup>
Carlyle, Ill.	Knights Landing, Cal.	Red Rock, Wash.
Circle, Alaska.	La Salle, Ill. <sup>1</sup>	Rio Vista, Cal.
Clay City, Ind.	Leadville special, Colo.	Roseville, Cal.
Coahoma, Miss.	Leavenworth, Kans.	San Marcos, Tex.
Columbiana, Ala.	Lincoln, Cal.	Sheridan, Cal.
Covington, Ohio.	McComb, Okla.	Sheridan, Wyo.-Mont.
Crater Lake National Park. <sup>1</sup>	McConnelsville, Ohio.	Southern California No. 3.
Danforth Hills, Colo.	Macon, Mo.	Sutton special, W. Va.
Dawson Springs, Ky.	Marcuse, Cal.	Taneytown, Md.-Pa.
Dundee, Miss.	Meadows, Idaho.	Uncompahgre, Colo.
Eaton, Colo.	Monticello, N. Y.	U. S. base, 8 by 12½ inches.
Ellijay, Ga.-N. C.-Tenn. <sup>1</sup>	Montevallo, Ala.	U. S. base, 49 by 76 inches. <sup>1</sup>
Ellsworth, Me.	Mount Vernon, Wash.	Vernon, Cal.
Emmitsburg, Md.-Pa.	Murphysboro, Ill.	Walnut Lake, Miss.
Fayetteville, W. Va.	Neenah, Wis.	Wheatland, Cal.
Fond du Lac, Wis.	Neversink, N. Y.	Winchester, Wash.
Fort Bayard special, N. Mex.	New Hope, Cal.	Winnebago special, Wis.
Fowlerville, Mich.	New Kensington, Pa.	Woodbridge, Cal.
Frazesburg, Ohio.	New Lexington, Ohio.	Zellenople, Pa.

<sup>1</sup> New editions.



### FIELD WORK BY THE DIRECTOR.

The Director did not make the usual inspection visits to field parties in the summer of 1910 for the reason that he attended the International Geological Congress held in Stockholm, Sweden, which afforded opportunity for conference with the administrative officers of the official geological surveys of other countries. The Director also visited the French Army Geographic Service, which makes the official topographic surveys, and the office of the Geological Survey of Great Britain. The delegation representing the United States Geological Survey at the Stockholm congress included also Messrs. Emmons, Hague, Becker, Lindgren, and Cross.

In November the Director visited the California oil fields with a view of ascertaining present conditions and made a report on the results to the Secretary of the Interior, urging remedial legislation. In May and June, 1911, in company with a geologist and an engineer, he made a preliminary examination of the two forest tracts in Georgia and Tennessee, on which favorable reports were afterwards submitted to the Secretary of Agriculture for the use of the National Forest Reservation Commission.

### GEOLOGIC BRANCH.

#### ADMINISTRATION.

The geologic branch embraces four divisions—(1) geology, C. W. Hayes in charge; (2) Alaskan mineral resources, A. H. Brooks in charge; (3) mineral resources, E. W. Parker in charge; and (4) chemical and physical research, G. F. Becker in charge.

The chief geologist, C. W. Hayes, has general supervision of the work of the geologic branch, and the divisions composing the branch cooperate effectively in the several lines of work which are being carried on. Members of one division are employed in the work of another whenever it seems desirable, and such transfer is easily effected. The statistical reports of the division of mineral resources are for the most part prepared by geologists, who are detailed to the work from the division of geology for a portion of the year.

#### PUBLICATIONS.

The publications of the year prepared in the geologic branch included 5 geologic folios, 1 professional paper, 19 bulletins, and the annual volumes on mineral resources. Besides these publications a considerable number of papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies. Such publications are ordinarily restatements

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of results in a more technical form, and are usually prepared by members of the Survey without compensation. Some original matter obtained incidentally during the course of the work and not appropriate for official reports has also been made the subject of unofficial publications.

The progress of geologic mapping during the year is shown on Plate I.

#### DIVISION OF GEOLOGY.

##### ORGANIZATION.

The scientific force at the beginning of the year consisted of 54 geologists, 58 assistant geologists, and 11 junior geologists. During the year there were 4 resignations, 1 death, and 39 appointments, resulting in a net gain of 34, the total being 157 at the end of the year. Of the total number, 92 were continuously employed, 37 carried on the per diem roll gave only a portion of their time to Survey work, and 33 were not employed during the year. In addition to the regular force 15 field assistants were employed for a portion of the year.

The work of the division is organized under a number of sections, as follows:

Areal and structural geology, Arthur Keith in charge.

Paleontology and stratigraphic geology, T. W. Stanton in charge.

Economic geology, metalliferous ores, Waldemar Lindgren in charge.

Economic geology, nonmetalliferous minerals, F. B. Van Horn in charge.

Economic geology, fuels, M. R. Campbell in charge.

Land-classification board, W. C. Mendenhall in charge.

The section chiefs have direct supervision, both in the field and in the office, of the work in their sections and are directly responsible for maintaining efficiency and a high scientific standard.

##### FIELD WORK OF THE CHIEF GEOLOGIST.

The administrative duties of the chief geologist are such as to prevent him from carrying on systematic field work. His work outside of the office, therefore, consists chiefly of field conferences for determining questions in dispute and for planning future work.

During November, 1910, the chief geologist was temporarily assigned to the War Department to procure data relating to the geologic conditions in the Canal Zone, and especially in the Culebra cut, for the use of the President. He made a study of the causes of landslides and other failures in the sides of the cut and of means for their prevention, and submitted to the Secretary of War a report on the subject, embodying conclusions and recommendations. A summary statement of the results of the work was included in the

President's message to Congress. As a result of recommendations contained in the chief geologist's report the Isthmian Canal Commission in December applied to the Survey for a geologist to make a thorough geologic study of the Culebra cut and of the Canal Zone generally. Assistant Geologist D. F. MacDonald was selected for the work, and in January was assigned to the Canal Commission and reported for duty to the chairman and chief engineer.

In March the chief geologist made a visit to southern Utah to determine the geologic relations of certain potash-bearing minerals reported to occur there. In May he attended a field conference with several Survey geologists in the Ducktown copper district, Tennessee, and another in Vermont in relation to certain disputed points in the geologic structure near Brandon.

The chief geologist was out of the United States for two months during the year, on leave without pay.

#### WORK OF THE CHIEFS OF SECTIONS.

*Section of areal and structural geology.*—The work of Arthur Keith has been, for the most part, of an administrative character, consisting mainly of conferences with other geologists and supervision and inspection of results in areal and structural geology, both in the field and in the office. Much of this work comes in connection with the geologic folios, in which responsibility for form and adequate treatment rests on Mr. Keith. The attainment of harmony and unity in the folios requires frequent conferences on all matters treated in them. Such conferences are also necessary for the maps and descriptions in reports dealing with areal geology, which form a large part of the survey publications.

A great deal of Mr. Keith's time has been devoted to service on committees, including those on geologic names, illustrations, plans, and maps. The largest single element of the committee work has been that on geologic names, under his chairmanship.

Maps submitted for folio publication of the following quadrangles were inspected: Boston, Marlboro, Greylock, Mass.; Taconic, Mass.-Vt.; Ellijay, Ga.; Ducktown, Tenn.; Frostburg, Md.

Field conferences were held by Mr. Keith with the geologists responsible for the areal geology in the following quadrangles: Sheffield, Pittsfield, Boston, Mass.; Peterboro, N. H.; Brandon, Vt.; Dahlonega, Ga.; Ducktown, Tenn.

Mr. Keith made a review of the areal geology of the Cowee and Kings Mountain quadrangles (N. C.), and continued, with D. B. Sterrett, the joint study of the areal geology of the Gaffney quadrangle (S. C.).

Special investigations were continued by Mr. Keith into the faulted structure of Hoosac Mountain, in the Greylock and Becket quad-

rangles, Mass. In association with L. M. Prindle, Mr. Keith made a special study of the subdivisions of the Cambrian and Ordovician strata in the northeastern part of the Hoosick quadrangle (N. Y.-Vt.) and the adjoining corner of the Cambridge quadrangle (N. Y.).

Reconnaissances were made by Mr. Keith in the following quadrangles: Dover, N. H.; Framingham, Mass.; Winston Salem, N. C.; Abbeville, S. C.; Suwanee and Atlanta, Ga.

The greater portion of Mr. Keith's office time was occupied with investigations and discussions in connection with geologic folios. The descriptive texts of eight folios in course of preparation were critically read, and the structural geology and areal mapping of these and many others were specially considered. In the editorial work Mr. Keith was assisted in the last half of the year by Laurence La Forge.

Numerous papers presented for publication by the Survey were critically read, and the geologic maps for Survey reports were examined. The scheme of separate representation on a single map of the faunal and lithologic elements involved in a geologic formation, which was proposed by Mr. Keith three years ago, is now being carried out in some of the folios and other publications of the Survey.

*Section of paleontology and stratigraphic geology.*—T. W. Stanton was absent from Washington on field duty from July 6 to October 1, 1910. His field studies were made mostly in cooperation with geologic parties engaged in areal and land-classification work in the coal and phosphate fields of the Rocky Mountain region, their main object being to gain personal detailed knowledge of the stratigraphic sections and to collect paleontologic evidence for use in correlation and definition of formations. The areas visited were Vermejo Park, N. Mex.; the Canon City coal field (Colo.) with W. T. Lee; the Apishapa quadrangle (Colo.) with G. W. Stose, for the purpose of identifying the Comanche series; the Colorado Springs and Denver areas (Colo.) with G. B. Richardson; Newcastle, Wyo.; a large area in eastern Wyoming, covered by wagon reconnaissance with A. R. Schultz, to visit parties under J. A. Davis near the Montana line, V. H. Barnett southeast of Gillette, D. E. Winchester near Douglass and the Lance Creek area, and C. H. Wegemann on the upper Powder River and in the Salt Creek oil field; Columbus, Mont., and the region to the north with W. R. Calvert and F. H. Knowlton; and the phosphate field of southeastern Idaho with R. W. Richards.

All of Mr. Stanton's time in the office has been occupied in the usual routine work, including the examination of the numerous current collections of fossils and the preparation of reports on them for the use of geologists, committee work, reading of referred manuscripts, and other administrative duties connected with the supervision of the section of paleontology and stratigraphy and the preser-

vation and classification of the collections. Under the last item, with the assistance of T. E. Willard, nearly all the large collections of Mesozoic invertebrates which were recently moved into the new building of the National Museum have been classified and arranged in cases so that they are easily accessible for study or quick reference.

*Section of economic geology, metalliferous ores.*—During the early part of July Waldemar Lindgren was engaged chiefly in administrative work in connection with the section of metalliferous deposits and paid a brief visit to Ducktown, Tenn., to inspect the geologic work there in progress. From July 23 to September 14 he was in attendance at the Eleventh International Geological Congress in Sweden. After his return he was engaged in administrative work for the division of mineral resources and for the section of metalliferous deposits, his time being about equally divided between the two. From December 1 to 22 he was on leave without pay, lecturing at the Massachusetts Institute of Technology. On his return he was occupied chiefly with administrative duties, except during about one week, which was devoted to a report on the Republic district, Washington. On May 19 he proceeded to Arizona, where he examined mines at Bisbee and inspected geologic work in the Tucson quadrangle. He spent the greater part of June in a geologic study of the new district at National, Nev. During the year he compiled and submitted for publication a report on the production of platinum in 1909.

*Section of economic geology, nonmetalliferous minerals.*—During the first half of the year F. B. Van Horn was occupied by administrative duties in Washington. From February 16 to March 10 he was in Florida and South Carolina, and from April 3 to April 14 in Tennessee and Arkansas, studying the occurrence and methods of mining of the phosphate deposits of those States. The rest of the year he spent in administrative work, mainly for the geologic branch, and as acting chief geologist.

Plans were formulated for a systematic search for commercial deposits of potash in this country. The appropriation for this work was not available until July 1, 1911, but it was thought desirable to do as much as possible toward getting the work well under way. As a result sites have been selected which appear most favorable for the accumulation of potash deposits, and drilling will be commenced very early in the new fiscal year.

Mr. Van Horn also prepared reports on the production of phosphate rock in 1909 and 1910 for publication in the volume "Mineral Resources."

*Section of economic geology, fuels.*—As in previous years, the work on fuels was in charge of M. R. Campbell, who divided his time between the field and the Washington office.

Mr. Campbell left Washington July 12, 1910, going first to the Yellowstone National Park to see if it was possible to prepare a popular description of the natural features of this park. This work was interrupted by a request from the Interior Department that Mr. Campbell should accompany C. S. Ucker, chief clerk, in an official trip of inspection through the new Glacier National Park. This trip extended from July 28 to August 9.

After a brief trip to Denver to attend to administrative duties, Mr. Campbell, at the request of Mr. Ucker, returned to the Glacier National Park to make an examination of mineral claims in the park. Forest fires prevented field work from August 18 to August 28, but active service began on the latter date and continued to October 3. Mr. Campbell visited parties engaged on coal work in the vicinity of Grand Junction, Colo., and then proceeded east, reaching Washington October 19, 1910.

In order to obtain information regarding reported coal fields on the Pacific coast of Mexico, Mr. Campbell made a hasty trip to the States of Sonora and Sinaloa, returning to Washington November 22, 1910.

During the winter the results of the field examinations were compiled in the office. This work involved the preparation of geologic maps of township plats showing the classification and valuation of the coal and oil lands examined, of special reports on the geology and economic resources of certain regions, and of the annual volume "Contributions to economic geology, Part II," which was submitted for publication.

Mr. Campbell left Washington June 6, 1911, to begin a study of the general geology of the Glacier National Park. After outfitting at Belton, Mont., he continued field work to the end of the present fiscal year.

*Subsection of fuels east of meridian 97°.*—In addition to supervising the work of the survey on the coal fields of Alabama, Tennessee, Illinois, and Missouri, David White made paleobotanic field examinations in the western Kentucky coal field, the Cherokee series of southern Iowa, the Cahaba Basin of Alabama, and the "Red Beds" of Oklahoma and Texas, the object of the work in the area last named being to obtain evidence as to the age of the rocks supposed to be near the horizon of the Wreford limestone of Kansas. Preliminary results of the work on the "Red Beds" have been reported in unofficial publications. Mr. White's other paleobotanic studies have been limited to those necessary for informal reports and correlations based on current collections submitted by Survey geologists.

The microscopic investigations of coals undertaken by the technologic branch of the Geological Survey to ascertain the relation of the kinds of plant material forming coals and the state of its preser-

vation to the chemical qualities and economic value of the coals have passed out of the hands of the Geological Survey since the organization of the Bureau of Mines, but by request of that bureau the supervision of this work was continued in Mr. White's charge. Mr. White's connection with this work, however, was terminated in June, 1911, by his submission of manuscripts discussing the local geologic relations of the coals examined, the general physiographic conditions attending the formation of the great coal beds, and the part played by metamorphism in the development of coals of different grades, the whole matter constituting his part of a report to be published by the Bureau of Mines.

#### GEOLOGIC WORK IN NEW ENGLAND STATES.

A small amount of geologic work was done in Maine in continued cooperation with the State, \$350 being spent by each Survey. Office work on the Eastport folio was continued by E. S. Bastin, who was assisted during the fall of 1910 by C. L. Breger. The office work on the maps and text has been carried as far as it can be until further paleontologic work is completed.

Mr. Breger left the survey December 31, 1910, when the paleontologic work in Maine was taken over entirely by H. S. Williams, under whose general direction Mr. Breger had been working. Prof. Williams has been engaged on the systematic determination and description of the large collections of fossils from the Eastport quadrangle and other portions of Maine. Work was continued on the preparation of the Mount Desert folio by C. W. Brown.

The final maps and text of the geologic folio covering the Ware quadrangle, Massachusetts, have been completed and submitted for publication by B. K. Emerson. Prof. Emerson has also completed the final revision of the geologic map of Massachusetts and Rhode Island on the scale of 4 miles to the inch.

In the northeastern part of the Hoosick quadrangle (Mass.-N. Y.) and the adjoining part of the Cambridge quadrangle (N. Y.-Vt.) special studies were carried on by L. M. Prindle and Arthur Keith in order to subdivide the Cambrian and Ordovician formations and to determine the structural relations of the region. Preliminary maps covering this work have been prepared by Mr. Prindle.

The preparation of the manuscript for the Housatonic (Mass.) folio by Joseph Barrell, in association with B. K. Emerson and T. N. Dale, is well advanced.

A folio covering the Boston and Boston Bay quadrangles has been in preparation for a number of years by members of the geological departments of Harvard University and the Massachusetts Institute of Technology. The completion of the folio was assigned to Laurence



La Forge and during the year the field work was finished; the office work on the folio is now well advanced. Although many facts concerning the geology of this region were known it was necessary for Mr. La Forge to cover the ground practically anew.

The marble quarries of Vermont have been examined by T. N. Dale, who has collected material for the preparation of an economic report on the marble belts of the western part of the State. Mr. Dale also prepared a supplementary report on the commercial granites of Massachusetts, to be published in Bulletin 470, and, together with H. E. Gregory, a report on the granites of Connecticut (Bulletin 484).

In addition to performing his duties as geologist in charge of the section of areal and structural geology, Arthur Keith devoted considerable time during the year to the study of some of the more obscure and complicated problems of New England geology. Among these are the structure of Hoosac Mountain and the Berkshire Hills, in Massachusetts; the age of the metamorphosed gneisses and schists northeast of Worcester, Mass.; the age of the quartzite and schist bodies west of the Boston Basin; and the stratigraphy of the district between Newburyport, Mass., and Portsmouth, N. H.

#### WORK IN NORTHERN APPALACHIAN REGION.

Several years ago G. K. Gilbert surveyed the Niagara Falls quadrangle in connection with his study of the history of the falls, but was unable to prepare the folio for publication. The completion of this work was assigned to E. M. Kindle and F. B. Taylor, Mr. Kindle taking the geology of the hard rocks and Mr. Taylor the Pleistocene deposits and the physiography of the region. Necessary additional field work was completed and the preparation of the folio is well advanced.

In continuation of a cooperative agreement with the State Geological Survey of New Jersey, the Survey's work on the Greenwood Lake-Ramapo folio was completed by W. S. Bayley. The discussion of the Paleozoic and later geology for this folio is being prepared by State geologist H. B. Kümmel. The manuscript of the descriptions of the pre-Cambrian rocks for the Delaware Water Gap folio has also been completed by Mr. Bayley, and Mr. Kümmel will prepare a description of the geology of the later formations on the New Jersey side of Delaware River. This work completes the mapping and description of the Paleozoic and pre-Cambrian formations of New Jersey.

The preparation of the text for folios on the Reading and Boyertown and the Honeybrook and Phoenixville quadrangles, in eastern Pennsylvania, was continued by Florence Bascom. Miss Bascom also completed a survey and petrographic study of the volcanic rocks of the Fairfield, Gettysburg, and Carlisle quadrangles and



made progress in the preparation of the text and description of these rocks for the Fairfield-Gettysburg folio, by G. W. Stose and Florence Bascom.

Work on the coal fields in Pennsylvania, prosecuted in cooperation with the State, has for the most part been confined to the preparation of reports on quadrangles previously studied. The folio manuscripts for the Hollidaysburg and the Barnesboro and Patton quadrangles were revised and completed by Charles Butts. On account of the intimate connection between the complex stratigraphic problems of the Hollidaysburg quadrangle and those of the adjacent Bellefonte quadrangle, now under study, further steps in the preparation and publication of the Hollidaysburg folio are temporarily postponed. Progress on the Punxsutawney, Houtzdale, and Curwensville folios, by G. H. Ashley, and on the Newcastle folio, by F. W. De Wolf, has been delayed by their duties as State geologists of Tennessee and Illinois, respectively, but it is confidently expected that the Punxsutawney and Newcastle folios will be submitted by the authors during the current year.

The Warren, Johnstown, Sewickley, and Burgettstown-Carnegie folios have been published, as also has a bulletin (No. 447) on the "Mineral resources of Johnstown, Pa., and vicinity." The Foxburg-Clarion folio was in press at the close of the year. The bulletin on the "Geology of the oil and gas fields in the Sewickley quadrangle," submitted by this Survey to the Topographic and Geologic Survey Commission of Pennsylvania in 1908 for publication, has recently been published by the State.

An arrangement was made with Prof. E. S. Moore, of Pennsylvania State College, for the survey of the Bellefonte quadrangle and the preparation of the geologic folio. It is expected that this folio will be submitted for publication during the coming year.

The manuscript for the Frostburg-Flintstone (Md.) folio, by G. W. Stose and C. K. Swartz, was submitted for publication, in cooperation with the Maryland Geological Survey.

#### WORK IN SOUTHERN APPALACHIAN REGION.

M. J. Munn has practically completed the field work for a report on the oil and gas fields of eastern Kentucky, in cooperation with the State Survey, and has submitted preliminary reports on the Campton oil field and on the oil and gas developments of Knox County, Ky., for publication in Bulletin 471.

Some additional field work was done by W. C. Phalen on the Kenova quadrangle (Ky.), and the folio has been submitted for publication.

Field work was carried on by G. W. Stose in the Abingdon quadrangle, in southern Virginia, and progress was made in the prepara-

tion of a geologic folio. The Cambrian and older rocks in about half of the quadrangle had already been surveyed by Arthur Keith, but the completion of the work was delayed pending topographic revision. Mr. Stose gave special attention to the examination of deposits of salt, gypsum, and iron in this area.

In Tennessee the survey of the Pikeville special quadrangle, in cooperation with the State, was nearly completed by W. C. Phalen, assisted by Henry Hart, of the Tennessee State Survey. A preliminary report by Mr. Phalen on the coal resources of the quadrangle has been submitted for publication by the State. In June, 1911, work was resumed on the Pikeville folio by Charles Butts, and a special study of the paleontology and stratigraphy of the region was undertaken by George H. Girty.

In cooperation with the State Survey a preliminary report on the oil and gas developments in Tennessee was prepared by M. J. Munn and published by the State Survey.

A detailed study has been made of the copper deposits at Ducktown, Tenn., and the areal and structural geology of the Ducktown special area. W. H. Emmons and F. B. Laney were associated in this work, Mr. Emmons studying especially the ore deposits and Mr. Laney the geology of the district. A brief paper on the ore deposits has been prepared by Mr. Emmons and Mr. Laney for publication in Bulletin 470 and also by the State Survey. A full report embodying the results of the investigation is nearly completed.

M. J. Munn made a reconnaissance examination of the Fayette gas field, Alabama, in cooperation with the Alabama Geological Survey, and has prepared a report for publication by the State. He has also prepared a briefer paper on this field for publication in Bulletin 471.

The survey of the Bessemer quadrangle (Ala.) was completed by Charles Butts for folio publication. From December to May Mr. Butts was occupied in office work in preparing reports on iron, marble, and dolomite of the Bessemer region for publication in Bulletin 470.

A report on the coal of the Dan River field (N. C.), based on a brief field examination made near the close of the previous fiscal year, has been submitted by R. W. Stone.

The areal and economic survey of the Gaffney and Kings Mountain region (N. C.—S. C.) was continued by Arthur Keith and D. B. Sterrett, and that of the Gaffney quadrangle was completed as far as the field surveys have gone.

The revision of the areal mapping of the Cowee quadrangle (N. C.) was completed by Mr. Keith and Mr. Sterrett. A report on the economic deposits of the Cowee quadrangle was prepared by

Mr. Sterrett, and the Cowee areal map for the folio was completed by Mr. Keith.

A reconnaissance of the Lincolnton quadrangle (N. C.) was made by Mr. Sterrett, and one of the Winston-Salem (N. C.), Abbeville (S. C.), and Suwanee and Atlanta (Ga.) quadrangles by Mr. Keith.

The areal and economic survey of the Dahlonega quadrangle (Ga.) was continued by F. B. Laney, the mapping for the northern half of the quadrangle being completed. In connection with this work Mr. Laney revised the areal mapping of the gneisses in adjoining parts of the Ellijay quadrangle (Ga.). The office work on the Dahlonega map was completed by Mr. Laney for the area covered in the field. The manuscript for the Ellijay folio has been submitted by Laurence La Forge for publication.

#### WORK IN ATLANTIC AND GULF COASTAL PLAIN.

In cooperation with the State geological surveys, a systematic study of the Atlantic and Gulf Coastal Plain was continued throughout the year. The work was carried on under the general supervision of T. W. Vaughan, who personally inspected several critical localities. W. B. Clark continued in immediate charge of the Coastal Plain work north of and including North Carolina, and Mr. Vaughan has immediate charge of the work in the remainder of the Coastal Plain.

Work was continued by W. B. Clark and his assistants on the State Survey in preparation of folios on the Coastal Plain of Maryland. This work is done in cooperation between the Federal and State surveys, and the manuscript for the Choptank folio, by B. L. Miller, was submitted for publication.

Field work was continued in western Florida and southern Alabama and Mississippi by G. C. Matson. Mr. Matson was for several months employed by the General Land Office to examine and classify public lands in Florida with reference to their value as phosphate lands.

L. W. Stephenson continued investigations of the Cretaceous rocks of the Coastal Plain in Alabama, Mississippi, Tennessee, Kentucky, Illinois, and Arkansas. During the year he completed reports on the stratigraphy of the Cretaceous deposits of Georgia and on the underground waters of the Cretaceous of Georgia. Mr. Stephenson also submitted two memoirs for publication as a professional paper—one on the Cretaceous deposits of the eastern Gulf region and the other on the species and varieties of *Exogyra* from the eastern Gulf region and the Carolinas.

Systematic investigations of the fossil plants found in the Tertiary and Cretaceous formations of the Coastal Plain were con-

tinued during the year by E. W. Berry. Field work was done in Georgia, Florida, Alabama, Mississippi, and Arkansas. In addition to this field work and the work of preparing reports on collections made by him and others, Mr. Berry has completed the manuscript for a bulletin on the Upper Cretaceous floras of South Carolina.

The study of the central Coastal Plain of Texas was continued by Alexander Deussen, who made reconnaissance surveys of Comal, Guadalupe, Gonzales, Dewitt, Victoria, and Calhoun counties. Analyses were made of 62 samples of water from typical wells in this region. Mr. Deussen also completed a short report on the clays of Texas for publication in Bulletin 470.

#### WORK IN CENTRAL STATES EAST OF MERIDIAN 97°.

In Illinois geologic investigations were continued under the co-operative agreement with the State, by which the results obtained by each Survey are made available for the use of the other. For the Federal Survey E. W. Shaw mapped the geology of the Tallula quadrangle and of one-half of the Illinois portion of the Galena and Elizabeth quadrangles. He also reviewed the Quaternary geology and physiography of several quadrangles previously surveyed in the southern part of the State. In the course of geologic work in southern Illinois during the last two years Mr. Shaw has worked out evidence of a new system of extinct lakes and has followed the lake beds southeastward as far as Madisonville, Ky. Mr. Shaw prepared a report on these lakes and transmitted it to the State Survey. In cooperation with members of the State Survey, Mr. Shaw prepared texts for the Murphysboro-Herrin and Tallula-Springfield folios. A report on the coal of the Springfield district was nearly completed and a general geologic report on the Belleville and Breese quadrangles was put in the form of a folio text. A paper on the clay resources of the Murphysboro quadrangle was prepared for publication in Bulletin 470. For the State Survey A. C. Trowbridge mapped the remaining areas in Illinois in the Galena and Elizabeth quadrangles, and U. S. Grant and G. H. Cady surveyed the greater part of the La Salle and Hennepin quadrangles. The results of Mr. Trowbridge's work will be published jointly with those obtained by Mr. Shaw. Messrs. Grant and Cady are preparing the La Salle-Hennepin folio, which will be furnished to this Survey by the State.

In cooperation with the State Geological Survey of Missouri, a survey of the coal fields of the State was begun, the work being placed in charge of Henry Hinds, of the Federal Survey, assisted by F. C. Greene, of the State Survey. The field investigations that will serve as the basis for economic reports on the coal resources and the

geologic structure of the coal fields of the State are approaching completion.

Additional work was done in July and August by C. E. Siebenthal in the Joplin lead and zinc district (Mo.) for the purpose of studying the deeper ore deposits in this district. At the same time Mr. Siebenthal revisited the Wyandotte quadrangle (Okla.) and brought up to date the notes on the mining geology, preparatory to writing the Wyandotte report and folio.

In Arkansas A. H. Purdue, assisted by H. D. Mizer, made a reconnaissance from the Hot Springs special quadrangle, the survey of which was completed last year, westward to the Caddo Gap quadrangle, for the purpose of connecting the two areas and correlating their stratigraphy. After completing this reconnaissance, Mr. Mizer devoted the remainder of the season to the areal mapping of the northern or mountainous portion of the De Queen quadrangle. The manuscript for the Eureka Springs-Harrison folio was completed and submitted for publication, and preparation of the Caddo Gap folio was advanced.

Some additional field work in the Lake Superior iron districts was undertaken during the year by C. K. Leith and W. J. Mead, under the direction of C. R. Van Hise. The results of this work were incorporated in the monograph on the Lake Superior region (Monograph LII), which is in press and will be published in October, 1911. The results of practically all exploratory work by the mining companies is placed at the disposal of Mr. Van Hise and his associates, so that the conclusions regarding the structure of the region and the distribution of the formations embody the best information obtainable.

The detailed study and areal mapping of the Pleistocene formations of southeastern Wisconsin has been completed by W. C. Alden northward to latitude  $44^{\circ}$ . In addition, during the last season, he surveyed portions of Manitowoc, Calumet, Winnebago, Waushara, Adams, and Juneau Counties. In the office Mr. Alden has nearly completed the manuscript for a professional paper covering the results of his work in southeastern Wisconsin.

The investigation of the Pleistocene geology in northern Michigan and adjacent portions of Wisconsin and Minnesota was continued by Frank Leverett, with the assistance of F. W. Sardeson. The State surveys of Wisconsin and Michigan cooperated to some extent in this work. Field work in northern Michigan was completed by Mr. Leverett, with the assistance of I. D. Scott, of the State Survey, and the map and report on the Northern Peninsula of Michigan, for publication by the State Survey, were completed. The monograph on the Pleistocene geology of Indiana and Michigan was completed by Mr. Leverett in association with F. B. Taylor.

## WORK IN THE WESTERN PUBLIC-LAND STATES AND TERRITORIES.

*Central States west of meridian 97°.*—N. H. Darton spent some months of the field season of 1910 in the Black Hills of South Dakota, mapping the pre-Cambrian rocks in the northern portion of the Deadwood quadrangle. He also adjusted the boundaries of several sedimentary formations in the Sturgis, Spearfish, and Rapid quadrangles and prepared portions of the text and maps for the Deadwood-Rapid folio. On October 15, Mr. Darton was transferred to the Bureau of Mines as geologist in that bureau. This transfer terminated his connection with the Geological Survey, a connection covering nearly 25 years.

Work was begun in June by Sidney Paige on the pre-Cambrian rocks of the Harney Peak quadrangle (S. Dak.) for folio publication.

The manuscript for the Bismarck (N. Dak.) folio has been submitted by A. G. Leonard for publication in cooperation with the State survey.

Progress has been made in preparing the Rapid-Deadwood (S. Dak.) folio, by N. H. Darton and Albert Johannsen.

At the time of the resignation of J. A. Taff from the Geological Survey (October 31, 1909) to accept employment as geologist in California, he had surveyed a number of quadrangles in Oklahoma, but had not completed the folios. The work of preparing these folios was assigned to C. D. Smith, who had acted as Mr. Taff's assistant and who was sent to California in order that he might readily confer with Mr. Taff concerning the work. Mr. Smith made considerable progress toward the completion of these folios. An arrangement was made with the State Survey of Oklahoma for cooperation in the survey of the Nowata quadrangle. The field work was three-quarters done by D. W. Ohern under the supervision of Mr. Smith, and was completed in the spring of 1911 by Mr. Smith, assisted by R. H. Wood. During the last three months of the year Mr. Smith has been engaged in surveying the Claremore quadrangle. This work is also being done in cooperation with the State and is practically completed.

*Rocky Mountain region.*—Work in the San Juan region, Colo., which has for several years been in charge of Whitman Cross, was continued by E. S. Larsen, jr., Mr. Cross being absent from the country attending the International Geological Congress at Stockholm. The survey of the San Cristobal quadrangle was practically completed by Mr. Larsen and some work was done on the Cebolla quadrangle. During the office season both Mr. Cross and Mr. Larsen continued the preparation of reports on the San Juan region.

During the year a systematic detailed study of the physiographic history of the San Juan district, with the areal mapping of the Quaternary deposits, was undertaken by W. W. Atwood, assisted



by K. F. Mather. Mr. Atwood completed the areal work for the Durango quadrangle and half of the La Plata quadrangle. He also made excursions into the higher mountains and to the southwest, over the adjoining plateaus, for comparative studies. This work is being carried on in close association with the studies of Whitman Cross and assistants on the geology of the older rock formations. The execution of the comprehensive plan adopted will require several years of field and office work.

The Apishapa quadrangle, in central Colorado, was mapped geologically several years ago by G. K. Gilbert, who was, however, unable to complete the folio for the quadrangle. Later the base map was improved and the geologic mapping was revised by G. W. Stose. The revision consisted chiefly of the mapping of a newly recognized Cretaceous formation. The folio covering this quadrangle is well advanced.

The mapping of the Deming quadrangle (N. Mex.) was completed by N. H. Darton. This work was begun several years ago in connection with studies of underground waters.

The bulletin on the Shinumo quadrangle (Ariz.), including an interesting portion of the Grand Canyon, has been completed by L. F. Noble, who has also completed a description of the Bright Angel quadrangle (Ariz.) to be printed on the back of the topographic sheet.

The manuscript for the Colorado Springs (Colo.) folio has been submitted by G. I. Finlay.

In New Mexico the Silver City quadrangle was surveyed by Sidney Paige, assisted by J. L. Rich, and the geologic folio was nearly completed. In addition to studies of the areal and structural geology, investigations were made of a number of mining districts in the quadrangle and several reports were prepared for publication in Bulletin 470. The quadrangle contains the Santa Rita mining district for which a special topographic map has been prepared. Detailed study of this mining district was not included in the work of Mr. Paige.

In connection with the investigation of underground waters by the Indian Office a geologic reconnaissance was made of the northwestern part of the Navajo Indian Reservation in Arizona and Utah by H. E. Gregory, assisted by J. E. Pogue. This was in continuation of work of the same character carried on during the preceding year.

During the summer of 1910 a beginning was made in the survey of the Glacier National Park in Montana by M. R. Campbell. Owing to the extensive forest fires the work was greatly impeded. In June, 1911, Mr. Campbell resumed field work in this park accompanied by W. C. Alden, who will make a special study of the Pleistocene deposits and glacial phenomena of the region.

*Classification of mineral lands.*—The study of the areal distribution and structure of the phosphate deposits in the northern Rocky Mountain region was continued during the year. R. W. Richards, assisted by G. R. Mansfield and J. H. Bridges, made a detailed examination of about 500 square miles of the withdrawn lands in Idaho, lying between the towns of St. Charles and Soda Springs, in Bear Lake and Bannock counties. Sufficient information was acquired to enable the Survey to place a valuation on these lands based on their content of phosphate. This information is available at any time that Congress enacts the necessary legislation for disposing of the lands at their appraised value. The area examined is estimated to contain over a billion tons of high-grade phosphate rock. A report on these deposits has been completed and submitted for publication in Bulletin 470. T. W. Stanton, G. H. Girty, and J. P. Smith spent considerable time with this party studying the associated paleontologic and stratigraphic problems. In June the field work on these phosphate deposits was resumed by Mr. Richards, assisted by Mr. Mansfield and E. L. Troxell.

A brief report on sulphur deposits near Soda Springs, Idaho, was prepared by Messrs. Richards and Bridges, and a report on the lead and copper deposits in the Bear River Range, Utah and Idaho, was prepared by Mr. Richards, both for publication in Bulletin 470.

A reconnaissance of parts of northwestern Wyoming and eastern Idaho, between Lander and Afton, was made by Eliot Blackwelder, assisted during a part of the season by C. L. Breger. The purpose of this reconnaissance was to determine the extent and character of the phosphate deposits northeast of the well-known Bear Lake region of southeastern Idaho. A brief report on the results has been submitted for publication in Bulletin 470, and the lands have been classified provisionally, preliminary to more detailed surveys which are contemplated in the immediate future.

Deposits of commercial rock phosphate in Montana, similar to those in Idaho, Wyoming, and Utah, were discovered in the vicinity of Melrose, Mont., and an area covering the known extent of the deposit was withdrawn from entry pending further field examination. A short report on these deposits by H. S. Gale was published as an advance chapter (A) from Bulletin 470, and a revision of this report is included in another advance chapter (470-H) now in press.

The description of the general geology of the Philipsburg quadrangle (Mont.) was completed by F. C. Calkins for publication as a professional paper on the geology and ore deposits, and the folio on the quadrangle was prepared in collaboration with W. H. Emmons, who wrote the sections relating to ore deposits.

An item in the sundry civil act of June 25, 1910, being an amendment to the act of February 26, 1895 (Stat. L., vol. 28, p. 683), en-



titled "An act to provide for the examination and classification of certain mineral lands in the States of Montana and Idaho," made an appropriation to the General Land Office for the completion of the classification as mineral or nonmineral of certain specified lands within the grant of the Northern Pacific Railroad Co. in Montana and Idaho. Under the authority of the Secretary of the Interior the field examination and classification of these lands was assigned to the Geological Survey. This work was done under the supervision of Waldemar Lindgren and the field and office work were placed in charge of H. S. Gale. D. F. MacDonald, assisted by E. L. Jones, jr.; F. C. Calkins, assisted by G. F. Loughlin; R. W. Stone, assisted by W. R. Hill; J. T. Pardee; and E. E. Smith were engaged in this work. A total area of 288,465 acres in Montana and Idaho has been examined and classified, as shown in the reports of the land-classification board. (See p. 68.)

From observations made in connection with his classification work Mr. Stone prepared a paper on the geologic relations of the ore deposits in the Elkhorn Mountains, Mont., for publication in Bulletin 470. In May and June the classification of Northern Pacific lands was resumed by parties in charge of F. C. Calkins, J. T. Pardee, and R. W. Stone.

*Classification of public lands.*—The field examinations necessary for the classification and valuation of the coal and oil lands of the West were continued throughout the year. As in previous years, the field work was in charge of M. R. Campbell. The following is a brief statement of the work accomplished and in progress at the end of the fiscal year, with the names of the geologists who are directly responsible for its prosecution:

Fort Berthold Indian Reservation, N. Dak. Examination made by M. A. Pishel. Land classified and report submitted.

Williston lignite field, N. Dak. Examination in progress by F. A. Herald, under the supervision of E. G. Woodruff.

Marmarth coal field, N. Dak. Examination in progress by C. J. Hares, under the supervision of E. G. Woodruff.

Perkins County coal field, S. Dak. Examination in progress by D. E. Winchester, under the supervision of E. G. Woodruff.

Harding County coal field, S. Dak. Examination in progress by E. M. Parks, under the supervision of E. G. Woodruff.

Coal near the Black Hills, Wyo.—S. Dak. Report submitted for publication by R. W. Stone. (Bulletin 499.)

Southern part of the Sidney coal field, Mont. Detailed examination made by Eugene Stebinger, under the supervision of W. R. Calvert. Land classified and report in preparation.

Culbertson coal field, Mont. Examined by A. L. Beekly, under the supervision of W. R. Calvert. Land classified and report in hand.

Glendive lignite field, Mont. Mapped and studied by J. H. Hance, under the supervision of W. R. Calvert. Land classified and report prepared.

Baker lignite field, Mont. Mapped by M. A. Pishel (temporarily in charge) and C. F. Bowen, under the supervision of W. R. Calvert. Land classified and report prepared.

Terry lignite field, Mont. Examination made by F. A. Herald, under the supervision of W. R. Calvert. Land classified and report well advanced. Investigation being continued by E. T. Hancock (temporarily in charge) and G. S. Rogers, under the supervision of E. G. Woodruff.

Part of Milk River coal field, Mont. Report begun by L. J. Pepperberg in 1909, completed by G. B. Richardson.

Big Snowy Mountains coal field, Mont. Geologic study for the purpose of ascertaining the eastern extent of the Judith Basin coal region, in progress by W. R. Calvert.

Flathead Indian Reservation, Mont. Examination of town and villa sites, in progress by Eugene Stebinger.

Tertiary coal fields of western Montana. Examination in progress by J. T. Pardee.

Belle Fourche Valley lignite field, Wyo. Examination in progress by V. H. Barnett, under the supervision of E. G. Woodruff.

Little Powder River coal field, Wyo. Examination made of the eastern part of the Little Powder River coal field by J. A. Davis, under the supervision of A. R. Schultz. Land classified and preliminary report prepared.

Western County coal field, Wyo. Examined by V. H. Barnett, under the supervision of A. R. Schultz. About 700 square miles classified; about 600 square miles withheld pending examination of the area to the east.

Lost Springs coal field, Wyo. Examined by D. E. Winchester, under the supervision of A. R. Schultz. Land classified and report in hand.

Platte River coal field, Wyo. Examined by D. E. Winchester, under the supervision of A. R. Schultz. Land classified and report in preparation.

Buffalo-Sheridan coal field, Wyo. Examination of the formations outcropping along the eastern base of the Bighorn Mountains being continued by C. H. Wegemann.

Sussex coal field, Wyo. Examined by C. H. Wegemann, under the supervision of A. R. Schultz. Land classified and report well in hand.

Powder River oil field, Wyo. Examined by C. H. Wegemann. Land classified and report practically completed (to appear in Bulletin 471).

Wiley quadrangle, Wyo. Examination to determine primarily the possible accumulation of oil, in progress by D. F. Hewett, under the supervision of E. G. Woodruff.

Southern part of Denver Basin coal field, Colo. Examination made by G. B. Richardson. Land classified and report practically prepared.

North Park coal field, Colo. Examination in progress by A. L. Beekly.

De Beque oil field, Colo. Examined by E. G. Woodruff and report well advanced.

Grand Mesa and West Elk Mountain coal field, Colo. Report submitted for publication by Willis T. Lee.

Coal resources of Gunnison Valley, Colo. Studied by E. G. Woodruff in company with G. B. Richardson. Report in hand.

Mancos coal field, Colo. Reconnaissance examination in progress by M. A. Pishel.

Canon City and Raton Mesa coal fields, Colo. and N. Mex. Stratigraphic studies made along the eastern front of the Rocky Mountains from Denver southward, by W. T. Lee, to determine the extent and value of certain unconformities and also for the general purpose of determining the geologic age of the coal-bearing rocks. Report in preparation.

New Mexico coal fields. Examination in progress by W. T. Lee.

Dayton and Toyah oil fields, N. Mex. and Tex. Examination made by G. B. Richardson.

Tertiary "lake beds" of the Snake River valley, Idaho. Segregation of noncoal or nonmineral areas in progress by C. F. Bowen.

Uinta Basin, Utah. Examination made of the Cretaceous coal-bearing rocks along the south flank of the Uinta Mountains, from a point near the Colorado line westward to Currant Creek Valley, by C. T. Lupton. Investigation southward through Strawberry Valley in progress. The report is well in hand.

Sunnyside quadrangle, Utah. Examination in progress by F. R. Clark, under the supervision of C. T. Lupton.

San Juan oil field, Utah. Report completed and submitted by E. G. Woodruff (in Bulletin 471).

Part of Parowan Range, Utah. Rapid reconnaissance of coal geology made by M. W. Ball.

Washington. Report on "Coals of the State of Washington," by E. E. Smith, submitted for publication (Bulletin 474). Land classified by M. W. Ball.

Oil prospects of northwestern Oregon. Report in preparation by C. W. Washburne.

#### WORK IN ROCKY MOUNTAIN MINING DISTRICTS.

The mining districts of the Dillon quadrangle (Mont.) were examined in July and August, 1910, by A. N. Winchell, who submitted for publication a preliminary report on these districts. Mr. Winchell also examined graphite deposits near Dillon and prepared a report for publication in Bulletin 470. A scientific discussion of the probable origin of graphite deposits in veins and pegmatites was published by Mr. Winchell in the journal *Economic Geology*.

The mineral resources of Lemhi County, Idaho, and the Bay Horse district, Custer County, Idaho, were examined by J. B. Umpleby, who has made progress in preparing a report embodying the results of his observations.

About four and a half months were spent in field work by E. S. Bastin, who was assisted by J. M. Hill, on the economic geology of the Central City quadrangle (Colo.). The areal mapping was completed, and the underground work was well advanced. In May Mr. Bastin resumed field work on this quadrangle.

At the request of the Department of Justice, J. M. Hill was detailed to make an examination of certain lands in the Olinghouse district, Washoe County, Nev. As a result of this work he prepared a paper on the Olinghouse and Ramsey mining districts, Nevada, for publication in Bulletin 470.

The report on the Breckenridge district, Colorado, was completed by F. L. Ransome during the summer of 1910 and is in press as Professional Paper 75.

During the winter Mr. Ransome, assisted by J. B. Umpleby, completed the mapping and study of the Ray quadrangle, Ariz. Mr. Ransome spent a short time at Tombstone, Ariz., studying mine levels

that there was reason to suppose would be submerged when pumping stopped. The mapping of the area covered by the Ray special map was completed, and work was begun on the area covered by the Miami special map, adjacent to the disseminated copper deposits. Progress has been made in the preparation of reports on the Ray and Miami areas, but additional study of the disseminated copper deposits is required before they can be completed.

At the request of the Post Office Department four groups of mining claims in the Cœur d'Alene district, Idaho, and two groups in western Montana were examined by F. C. Schrader, who subsequently submitted reports on them and gave testimony in the Federal district court at Spokane, Wash. Mr. Schrader's observations made during these examinations and earlier examinations for the Forest Service and Land Office in neighboring fields in 1908 enabled him to prepare a paper on gold-bearing ground moraine in northwestern Montana, with generalizations on similar occurrences of placer gold elsewhere in the Northwest. The report is now in press as a paper in Bulletin 470.

A geologic reconnaissance of the Jarbidge, Contact, and Elk Mountain mining districts in Elko County, Nev., was made by Mr. Schrader, assisted at Jarbidge by R. D. Pickett and at Contact by N. W. Sweetser. A report with maps and illustrations (Bulletin 497) was subsequently submitted on these districts.

The geologic map and the study of the ore deposits of the Ely special area, Nevada, were completed by A. C. Spencer, who also studied in detail the relations of the important deposits of disseminated copper ore of the district. The report on this district is well advanced and will soon be submitted for publication.

Field work was completed on the Frisco district, Utah, by B. S. Butler, who also made a reconnaissance of the Lincoln, Granite, Pine Grove, Gold Springs, and State Line districts, Utah, and of the Fay district, Nevada. Reports on these districts are in preparation.

The final report on the Park City district, Utah, the preparation of which has been delayed by the resignation of J. M. Boutwell from the survey, was completed by him and submitted for publication in May, 1911.

Progress was made on the revision of the Leadville monograph until its interruption by the death of S. F. Emmons on March 28, 1911. Mr. Emmons was assisted in this work by J. D. Irving, of Yale University, with whom arrangements have been made for its completion.

A report on the ore deposits of Lake City, Colo., has been completed during the year by J. D. Irving and Howland Bancroft, and is in press as Bulletin 478.

## WORK ON THE PACIFIC COAST.

An additional investigation of the ore deposits of northeastern Washington was made by Howland Bancroft, and a report covering his work has been completed. He also wrote a report on the lead and zinc deposits of the Metaline mining district, Washington, which forms a part of Bulletin 470.

The survey of the Klamath Mountains of northern California and Oregon has been continued by J. S. Diller, who, during the year, has mapped in detail one-third of the Big Bar quadrangle and prepared a paper on the auriferous gravels of the Trinity River basin, to be published in Bulletin 470.

Additional field work in the copper-mining districts of Shasta County, Cal., was done by L. C. Graton, who made considerable progress toward completing the final report being prepared by him and B. S. Butler, which will be published as a professional paper of the Survey.

The field work on the Randsburg quadrangle (Cal.) was completed by F. L. Hess, and the report is in progress.

The manuscript for the San Francisco (Cal.) folio has been submitted for publication by A. C. Lawson. In this work Prof. Lawson was assisted by several instructors and graduate students in the University of California.

The manuscript for the Ventura (Cal.) folio has been nearly completed for publication by Ralph Arnold and J. R. Pemberton.

Additional work was done in the Corona quadrangle (Cal.) by E. S. Larsen, jr., and progress is being made on the folio.

The investigations of the California oil fields were continued by Robert Anderson, assisted by R. W. Pack. Special attention was given to regions having prospective value for oil, with the aim of carrying the geologic work ahead of development and outlining the areas in which oil is likely to occur. During the summer and fall of 1910 the east flank of the Diablo Range between Panoche and Livermore valleys was examined in detail, thus completing a study of the whole west side of the San Joaquin Valley. In addition, a reconnaissance examination was made around the south end of the San Joaquin Valley. This work resulted in the classification of several areas as possible oil land and the restoration to entry of other areas which had been temporarily withdrawn pending examination but which proved to afford no promise of oil. A preliminary report on the Cantua-Panoche region by Robert Anderson (in Bulletin 431) was published in the fall of 1910. In the spring of 1911 a full report on the entire east flank of the Diablo Range north of Coalinga was brought well toward completion, and a preliminary report on the south end of the San Joaquin Valley was prepared for publication in Bulletin 471.

## GENERAL GEOLOGIC AND PALEONTOLOGIC WORK.

During the year W. H. Dall continued his studies on the Tertiary faunas of North America. He spent some time in visiting a large number of private and public collections of Tertiary and later fossils on the Pacific coast, thus accumulating a large amount of interesting material and information concerning the Pacific coast Tertiary deposits, in the study of which he is engaged. Good progress has been made in the preparation of a card catalogue of the Tertiary fossils of the Pacific coast, supplementary to that already in use for the eastern Tertiary fossils. Large collections of Tertiary fossils have been received from geologists working on the Atlantic and Gulf coastal plains and have been arranged and identified.

In addition to supervising paleontologic work, T. W. Stanton has continued his studies of the Mesozoic fossils, giving special attention to the correlation of the coal-bearing formations of the Rocky Mountain region. He has also rendered material assistance in determining Cretaceous fossils from the Atlantic and Gulf coastal plains.

In connection with his stratigraphic work T. W. Vaughan continued his studies of the Florida keys, reefs, and marine bottom deposits, under the auspices of the Carnegie Institution of Washington, in cooperation with the Geological Survey, having been engaged in these investigations from May 31 to June 30, inclusive. Besides preparing a summary report of his investigation of the physical conditions under which reef corals live and their rate of growth, for the Carnegie Institution Yearbook No. 9, 1910, he wrote an article entitled "The physical conditions under which Paleozoic coral reefs are formed," which has been published in the bulletin of the Geological Society of America. Mr. Vaughan has succeeded in rearing coral colonies from larvæ at the Tortugas laboratory of the Carnegie Institution. In estimating the rate of growth of coral reefs it is essential to know the rate of growth of the various kinds of coral composing the reefs, and the results obtained by Mr. Vaughan constitute the first trustworthy data that have been obtained for a solution of this problem. Mr. Vaughan also obtained additional information on the calcareous bottom deposits now forming in shallow water along the Florida coast.

The investigation of Triassic paleontology and stratigraphy in Utah and Idaho has been continued by J. P. Smith, of Leland Stanford Junior University. Mr. Smith visited the parties engaged in the study of the phosphate deposits in Idaho and rendered material assistance in their work. The monograph on the marine Middle Triassic fossils of America has been completed by Mr. Smith and transmitted for publication. His report on the Lower Triassic



faunas is well advanced, although descriptions of the species are still in preliminary form and will require much revision.

Investigation of Carboniferous invertebrate paleontology was continued by G. H. Girty, who spent four months in field work, chiefly in Idaho, New Mexico, Texas, and Tennessee, with less time in Ohio, Utah, and West Virginia. He made extensive collections of fossils and exact stratigraphic observations relating to them, and determined the geologic age and correlation of horizons for the parties with which he was associated. He completed a report describing the fauna of the Wewoka formation of Oklahoma and spent much time in arranging collections and preparing reports on fossils referred to him from different field parties in connection with their work.

In addition to his work on the Niagara quadrangle, mentioned elsewhere, E. M. Kindle continued investigations, begun the preceding season, of problems of stratigraphy and correlation relating to the Devonian formations of Pennsylvania and the southern Appalachian region. He also spent much time in preparing and studying Devonian fossils collected by geologists and submitted to him for determination.

Studies of the Cambrian, Ordovician, and Silurian rocks in the Appalachian and Mississippi valleys were continued by E. O. Ulrich, with the assistance of Edwin Kirk. The general results of Mr. Ulrich's stratigraphic studies of American Paleozoic deposits during the past 20 years are presented in a work entitled "Revision of Paleozoic systems," published by the Geological Society of America.

In connection with the classification of coal land F. H. Knowlton, assisted by A. C. Peale, spent the field season in studying paleontologic and geologic problems in the Rocky Mountain region. He procured a large amount of paleobotanic and other material for use in correlating several upper Cretaceous and Tertiary formations. During the office season Mr. Knowlton studied and reported on more than 400 collections of fossil plants for the use of geologists in locating and correlating Mesozoic and Cenozoic horizons, mainly in the Rocky Mountain region. One of these collections, that from the Trinidad-Raton coal field, comprised nearly 3 tons of material. A number of scientific papers were prepared for outside publication.

Under the joint supervision of Messrs. Knowlton and White the work on the bibliography and compendium of paleobotany has been continued by Miss C. H. Schmidt. The estimate made in January, 1910, that this work would be completed by the end of the fiscal year 1912 seems likely to be fully justified, as satisfactory progress has been made during the year.

The geologic map of North America, which has been compiled under the general supervision of Bailey Willis, is now in press.

During the last year, owing to the absence of Mr. Willis from this country, the work on this map has been in charge of G. W. Stose, who has given to the work a large amount of attention. Credit is also due in this connection to the geologists of the Survey generally, who have contributed largely to the completeness of the work. Mr. Stose has continued in charge of the editing of the maps of geologic folios, his detailed report as editor of geologic maps appearing on pages 134–135.

During June, 1911, A. C. Spencer devoted his attention to the study of certain tracts of land on the headwaters of Tennessee River in Fannin County, Ga., and Blount County, Tenn., which had been offered to the Secretary of Agriculture under the Weeks Act, providing for the acquisition of lands for the purpose of conserving the navigable rivers. Careful examination of these tracts resulted in reports affirming that forest control would tend to ameliorate existing conditions, which were found to be favorable to rapid erosion and soil waste in the forested areas. The greatest factor in excessive erosion has been the frequent burning over of forest lands, which destroys the leaf mat and underbrush that naturally prevents the soil from washing. If fires can be kept out permanently a very material decrease is to be expected in the amount of sediment delivered to the local creeks, and the sediment eventually delivered to Tennessee River would be lessened in proportion.

#### WORK OF COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names is composed of Arthur Keith (chairman), M. R. Campbell (vice chairman), W. C. Alden, W. C. Mendenhall, F. L. Ransome, T. W. Stanton, G. W. Stose, and David White. The clerical work of the committee is performed by one clerk, Miss M. G. Wilmarth, who is designated as the secretary.

According to the Director's instructions of January 30, 1909, "It is the duty of the committee on geologic names to consider all geologic names used by members of the Geological Survey in both official and unofficial publications. When manuscripts are received by the committee they shall be examined as soon as practicable and the committee shall decide whether the names employed are permissible or not."

The chief objects of the committee are to insure uniformity in geologic classification and nomenclature in Survey publications, to prevent unnecessary duplication of geologic names, and to reduce the number of names employed, through correlation of the formations from one area to another. The main criteria on which the decisions of the committee are based are priority of publication, significance acquired by usage, and adequacy of definition and type locality. No one of these criteria is relied on to the exclusion of the others.



The records of the committee comprise (1) a catalogue of geologic names considered by the committee, arranged alphabetically, the action taken for each manuscript being recorded; (2) a catalogue of American geologic names in the literature, also arranged alphabetically, each published description of a formation being recorded (this catalogue is the work of J. M. Nickles, of the library staff); (3) a catalogue of the geologic names in the literature, arranged by States; (4) a catalogue of geologic columnar sections approved by the committee, arranged by States, the area to which each columnar section applies being located on the appropriate State map; and (5) a catalogue of geologic columnar sections in the United States, classified by States, compiled from existing literature, the areas being located on a set of State maps. The last catalogue is not complete but is being brought up to date as rapidly as possible. It is designed to prevent unnecessary duplication of geologic names. All these records, except as noted above, have been prepared and are kept up to date by the secretary of the committee.

The amount of labor and research which devolves upon the committee can be understood from the statement that during the last fiscal year it considered 125 manuscripts, comprising a total of about 17,000 pages and more than 2,500 geologic names. These manuscripts discussed the geology of all parts of the United States.

#### **LAND-CLASSIFICATION BOARD.**

##### **ORGANIZATION.**

The organization of the land-classification board during the fiscal year 1910-11 has continued along the general lines indicated in previous annual reports. The board is a section of the geologic branch administered by a chairman and a general advisory committee, the latter made up of the chiefs of branches, divisions, and sections, whose field work supplies the greater part of the fundamental data that form the basis of the board's action. Within the land-classification board are subordinate boards, each of which deals directly with one of the natural resources and certain public-land problems related thereto. The number of these subordinate boards may be increased or diminished from time to time as the exigencies of the work require. At present there are subboards that deal with the classification of coal, oil and gas, phosphate, and metalliferous deposits and with irrigation and power matters. On December 1, 1910, A. C. Veatch, until that date in charge of the board, applied for and was granted leave of absence. This, together with other changes in the personnel, necessitated certain measures of reorganization, which were effected on January 1, 1911. By virtue of these changes and

others made later in the fiscal year, the organization of the board on June 30, 1911, is as follows:

W. C. Mendenhall, in charge of the board, chairman of the advisory committee, and ex officio chairman of each of the classification boards.

N. C. Grover, chief engineer of the board and ex officio member of irrigation and power boards.

W. R. Calvert, chairman of the coal board.

M. W. Ball, chairman of the oil, phosphate, and metalliferous deposits boards.

W. B. Heroy, chairman of the irrigation and power boards.

The additional members of the advisory committee and subboards are as follows:

Advisory committee: C. W. Hayes, M. O. Leighton, Waldemar Lindgren, M. R. Campbell, A. H. Brooks.

Coal-classification board: M. W. Ball, A. L. Beekly, C. T. Lupton.

Oil-classification board: Robert Anderson, C. H. Wegemann.

Phosphate-classification board: H. S. Gale, R. W. Richards.

Metalliferous deposits classification board: H. D. McCaskey, E. S. Bastin.

Irrigation board: J. C. Hoyt, O. E. Meinzer.

Power board: M. O. Leighton, Herman Stabler.

The fundamental purpose for which the board and subboards were created is to carry out the mandate of the organic act of the Geological Survey, in which it is charged primarily with the classification of the public lands. This work of classification involves many questions as to procedure in public-land matters, partly incidental to the classifications and partly the result of statutes recently enacted, in the administration of which certain responsibilities devolve upon the Survey, either directly or in cooperation with other bureaus in the Interior Department.

The board's operations during the year 1910-11 differed from those of previous years rather in the volume of the work done than in the nature of the work. The amount has been increased, for example, by certain cooperative agreements with the General Land Office, by virtue of which the commissioner requests information on the mineral or power value of lands for which patent is asked, either before or after examination by special agents. The Indian Office, under the Secretary's orders, likewise refers to the Geological Survey lands listed for patent and lands which it is proposed to eliminate from the reservations and throw open for settlement, in order that the mineral or nonmineral character or the power value of the lands affected may be determined. Proposed eliminations from national forests are likewise referred for report as to mineral character and power value, and all Carey Act lists are submitted to the Survey for a statement as to the sufficiency of the water supply and the adequacy of the proposed plan of irrigation before the lists are approved for segregation.

These various types of work are more fully discussed under appropriate headings in the statements which follow.

COAL.

*Classifications.*—Coal lands have been classified during the year at an increased rate. The area appraised as coal land during the fiscal year 1909–10 was 4,876,196 acres; during 1910–11 the area so appraised was 7,821,508 acres. The area classified as noncoal land during 1910–11 is 2,386,444 acres greater than that so classified in 1909–10. On the other hand, the average price fixed per acre and the total appraised value are notably less for the last year than for the preceding year. The difference is due to a concentration of work in the lignite and low-grade subbituminous fields of eastern Montana and Wyoming, where the appraised values under the regulations are the minimum fixed by law. The following table shows the progress of coal-land classification, by States, during the year:

*Progress of classification of coal land during the year ending June 30, 1911.*

[Areas in acres.]

\* Total reduction in area classified under old regulations, comprising lands either rewithdrawn or reclassified under new regulations.

The charge has been made that the classification policy has been harmful to the coal industry of the West by placing prohibitive prices on the public coal lands. The fact that the coal production of the Rocky Mountain States in 1910 showed an increase of 14.7 per cent over the production of 1909 indicates that the coal industry has not been seriously injured. The following table refutes any statement that the prices fixed are prohibitive, by showing that the sale of coal lands during the four fiscal years since the adoption of the classification policy has been 12½ per cent greater than during the four preceding years, while the increase in receipts from the sales has been 36 per cent.

*Sales of coal lands at all prices, in the United States, exclusive of Alaska, from 1903 to 1911.*

Fiscal year.	Entries.	Acres.	Receipts.	Average price per acre.
1903-4.....	190	28,827.42	\$395,209.90	\$13.74
1904-5.....	158	20,456.35	277,402.40	13.56
1905-6.....	244	42,143.39	538,683.70	12.54
1906-7.....	157	20,387.02	303,255.60	14.80
Four years prior to July 1, 1907.....	749	111,814.18	1,514,551.60	13.54
1907-8.....	299	58,047.10	647,584.55	11.15
1908-9.....	182	26,590.68	502,743.65	18.90
1909-10.....	189	26,074.16	657,175.80	25.20
1910-11.....	83	15,284.89	251,323.03	16.44
Four years since July 1, 1907.....	753	125,996.83	2,058,827.03	16.34

Many of the lands sold since July 1, 1907, have doubtless been unclassified lands sold at the minimum price, but the following table shows that by no means all the sales have been at minimum, and that the increase in sales since July 1, 1907, is much more than equaled by the sales at classified prices greater than the minimum. In other words, the acreage sold at the minimum has been less since classification begun than in the same period preceding, although the total acreage sold has increased, indicating, certainly, that the classifications have not prohibited the purchase of coal lands.

*Sales of coal lands at various rates since July 1, 1907.*

Price per acre.	Entries.	Acres.	Receipts.	Price per acre.	Entries.	Acres.	Receipts.
\$10.00 .....	328	46,022.21	\$461,099.33	\$75.00 .....	2	161.23	\$12,092.25
15.00 .....	15	2,310.55	34,658.25	90.00 .....	1	121.69	10,952.10
17.50 .....	1	40.00	700.00	92.00 .....	1	40.00	3,680.00
20.00 .....	258	52,833.03	773,028.80	100.00 .....	1	38.48	3,848.00
25.00 .....	37	11,171.68	131,671.70	120.00 .....	1	40.00	4,800.00
30.00 .....	23	3,159.81	94,794.30	135.00 .....	1	80.00	10,800.00
35.00 .....	2	239.78	8,392.30	140.00 .....	1	120.00	16,800.00
40.00 .....	8	800.06	32,002.40	170.00 .....	1	39.89	6,781.30
45.00 .....		240.00	10,800.00	180.00 .....	1	40.00	7,200.00
49.00 .....	1	40.00	1,960.00	270.00 .....	1	39.79	10,743.30
50.00 .....	69	8,218.63	409,023.00				
65.00 .....		200.00	13,000.00		753	125,996.83	2,058,827.03

*Withdrawals.*—Two great withdrawals of land for determination of its content of coal were made during the year, one in the Dakotas and one in Idaho. The areas withdrawn in the Dakotas, judged from the facts gathered in field examinations made up to date, promise to be very largely coal land. The area withdrawn in Idaho, on the other hand, is being shown by field survey to be mainly noncoal land, and more than a million acres have already been classified as noncoal land. It is significant that the area withdrawn for examination for coal has been increasing year by year, rather than decreasing constantly by restorations made as a result of classification, as might be expected. Although the field examinations have each year increased the area classified, and therefore subtracted from the areas withdrawn, the restorations have been more than offset by the withdrawal of areas indicated as coal bearing by new information or by a study of data already at hand. However, in Colorado, Montana, and Wyoming, where the field work was concentrated during the season of 1910, the restorations far outbalance the withdrawals. It is probable that the maximum withdrawn area has been reached this year and that the withdrawals will steadily decrease hereafter.

*Withdrawals of coal lands, fiscal year 1910-11, in acres.*

States.	Withdrawals outstanding July 1, 1910.	New with- drawals.	Restorations.	Withdrawals outstanding June 30, 1911.
Alaska.....	(a)			(a)
Arizona.....	161,210		42,492	118,718
California.....		239,903		239,903
Colorado.....	6,656,518	977,944	2,117,124	5,517,338
Idaho.....		8,265,970	1,280,553	6,985,417
Montana.....	23,920,978	740,849	4,771,356	19,890,471
Nevada.....		92,141		92,141
New Mexico.....	3,155,295	3,120,530	466,335	5,809,490
North Dakota.....		18,454,490		18,454,490
Oregon.....	379,452		375,931	3,521
South Dakota.....		2,869,377	494,114	2,375,263
Utah.....	5,897,958	1,054,154	730,798	6,221,314
Washington.....	2,210,847		40	2,210,807
Wyoming.....	10,854,704	780,731	4,621,892	7,013,543
	53,236,962	36,596,089	14,900,635	74,932,416

<sup>a</sup> Area unknown.

*Applications for reclassification.*—The beneficial effects of the act of June 22, 1910 (Stat. L., vol. 36, p. 583), providing for agricultural entries for surface rights only on lands classified as coal lands, are shown by the decreased number of applications for the reclassification of areas so classified. Whereas 127 applications were received during the fiscal year 1909-10, but 48—only a little over one-third that number—were received during the year 1910-11. Before the passage of this act lands classified as coal bearing could not be disposed of except

as coal land at the appraised price. As a result agricultural development of these areas was impossible, and many applications were received alleging the classification to be erroneous and praying for its reversal in order that agricultural entries might be made. Now agricultural entries may be made upon coal lands, the entryman receiving title to the surface only and the United States reserving title to all underlying deposits of coal. A summary of the applications acted upon during the year follows:

*Applications for reclassification of coal land, fiscal year 1910-11.*

State.	Number received.	Denled.	Pending.
Colorado.....	2	4	0
Montana.....	18	18	1
North Dakota.....	1		1
Utah.....	7		7
Wyoming.....	20	1	19
	48	23	a 28

a One application from Montana and two from Colorado received before June 30, 1910.

*Applications for classification.*—Agricultural entries for surface rights only may not be commuted, a certain proportion of the entry must be cultivated each year, and the total area which may be included in a desert-land entry for surface rights is restricted to 160 acres. These conditions lead to the submission of applications for the classification as noncoal land of areas withdrawn pending their classification as to coal. As these withdrawals are usually made in order to retain the title to the coal deposits in the Government until field examination can be made on which to base a classification, most of such applications can not be granted. It has, however, been possible, from information at hand, to grant 4 of the 46 such applications received during the year.

The following table shows the distribution of the applications:

*Applications for classification of coal land, fiscal year 1910-11.*

State.	Number received.	Ap- proved.	Denled.	Pending.
Colorado.....	2	1	1	
Idaho.....	26		26	
Montana.....	11	2	5	4
New Mexico.....	4		3	1
South Dakota.....	1	1		
Washington.....	1		1	
Wyoming.....	1			1
	46	4	36	6

## OIL.

Pending the enactment of legislation for disposing of oil and gas deposits on the public domain, and because it seems desirable to retain certain of these deposits for use as fuel by the American Navy, all public lands known or thought to contain valuable deposits of oil or gas are withdrawn from all forms of disposal. During the year 640,604 acres of possible oil land in California and Wyoming were withdrawn from entry, and 1,232,719 acres in the same States, shown by field examination to be nonoil lands, were restored. In addition, all oil lands in Alaska, comprising an unknown area, were withdrawn during the year. In the early part of the year the outstanding withdrawals made by the Secretary of the Interior were ratified, confirmed, and continued in full force and effect by the President under the act of June 25, 1910. The following table contains a summary of all action affecting the status of oil lands prior to June 30, 1911:

*Withdrawals of oil lands, fiscal year 1910-11, in acres.*

State.	Outstand- ing July 1, 1910.	New with- drawals. <sup>a</sup>	Restora- tions.	Outstand- ing June 30, 1911.
Alaska.....		Unsurveyed.		Unsurveyed.
Arizona.....	230,400			230,400
California.....	2,498,173	305,802	1,211,271	1,592,704
Colorado.....	87,474			87,474
Louisiana.....	414,720			414,720
New Mexico.....	419,901			419,901
Oregon.....	74,849			74,849
Utah.....	581,566			581,566
Wyoming.....	255,461	334,802	21,448	568,815
	4,562,544	640,604	1,232,719	3,970,429

<sup>a</sup> Excluding changes in forms of withdrawals.

## PHOSPHATE.

During the year a deposit of phosphate rock in southwestern Montana, similar in character to the deposits of Utah, Idaho, and Wyoming and at the same geologic horizon, was discovered by H. S. Gale, of the Survey. This discovery is important not only because of the quantity of phosphate found, but because it indicates the possibility that the deposits of phosphate rock are distributed over a much wider territory than had formerly been supposed.

In the early part of the year the outstanding withdrawals of phosphate land made by the Secretary of the Interior were ratified and continued in full force and effect by the President under the act of June 25, 1910 (Stat. L., vol. 36, p. 847). The area withdrawn as a result of the discovery in Montana comprises 33,950 acres, which, with withdrawals in Florida and Utah, makes a total of 65,589 acres



withdrawn during the year. Field examinations in Idaho resulted in the restoration of 149,929 acres, leaving in phosphate withdrawals June 30, 1911, a total of 2,399,416 acres. A summary of the outstanding withdrawals follows:

*Withdrawals of phosphate lands, fiscal year 1910-11, in acres.*

State.	Outstanding July 1, 1910.	New withdrawals. <sup>a</sup>	Restorations.	Outstanding June 30, 1911.
Florida.....	2,400	35,439	.....	37,839
Idaho.....	1,102,317	.....	149,929	952,388
Montana.....	.....	33,950	.....	33,950
Utah.....	107,545	200	.....	107,745
Wyoming.....	1,267,494	.....	.....	1,267,494
	2,479,756	19,589	149,929	2,399,416

<sup>a</sup> Excluding changes in form of withdrawals and rewithdrawals.

METALLIFEROUS DEPOSITS.

Under the act of February 26, 1895 (Stat. L., vol. 28, p. 683), provision was made for classifying with regard to their mineral or nonmineral character the lands within the Northern Pacific Railroad grant in Montana and Idaho. The classification made proved unsatisfactory for many areas and a reclassification was provided for in the sundry civil act of June 25, 1910 (Stat. L., vol. 36, p. 703). At the request of the General Land Office the reclassification was made by the Survey. The results of the work of the year are shown in the following table:

*Lands in Northern Pacific Railroad grant in Montana and Idaho classified during fiscal year 1910-11, in acres.*

State.	Mineral.	Nonmineral.	Total.
Montana.....	130,386	21,722	152,108
Idaho.....	45,645	90,712	136,357
	176,031	112,434	288,465

WATER POWER.

*Withdrawals and restorations.*—During the year the work of classifying the public lands with relation to their value for water-power development has followed the general plan pursued in previous years. On July 2, 1910, the earlier withdrawals, amounting to 1,454,499 acres, were ratified and continued by the President under the authority conferred by the act of June 25, 1910 (Stat. L., vol. 36, p. 847). As a result of field investigations, 143,555 acres included

in withdrawals were determined to be without value for power purposes and were restored to the public domain and 204,460 acres were included in new withdrawals, the total area withdrawn at the close of the fiscal year amounting to 1,515,423 acres.

The status of power-site withdrawals by States is shown in the following table:

*Water-power site withdrawals, fiscal year 1910-11, in acres.*

State.	Outstand- ing July 1, 1910.	New with- drawals during fis- cal year.	Restora- tions dur- ing fiscal year.	Outstand- ing June 30, 1911.
Alaska.....				
Arizona.....	107,550	106,000	160	213,390
California.....	47,819	5,870	0	53,689
Colorado.....	201,549	10,131	2,506	209,174
Idaho.....	230,971	16,458	17,756	229,692
Minnesota.....		8,388		8,388
Montana.....	122,515	16,803	11,631	127,687
Nevada.....	14,091	1,284		15,375
New Mexico.....	14,536		4,830	9,706
North Dakota.....				
Oregon.....	176,721	7,948	22,874	161,795
South Dakota.....				
Utah.....	379,912	1,080	33,740	347,252
Washington.....	55,439	26,404	1,457	80,386
Wyoming.....	103,396	4,094	48,601	58,889
	1,454,499	204,460	143,555	1,515,423

*Applications for reclassification.*—Twenty-one applications for reclassification of lands withdrawn because of their value for power purposes have been received during the fiscal year. Action has been taken on nine of them.

*Right-of-way applications.*—The examination of applications for right of way across the public lands for railroads, canals, ditches, and reservoirs for irrigation, mining, and municipal supply and structures for power development has been continued by the Survey. At first the inquiry was made primarily for the purpose of determining the effect which the approval of the application and the construction of the proposed works would have on future power development, but its scope has been broadened to include the investigation of the water supply and the general engineering feasibility of power and irrigation projects. If it appears that the approval of a right of way would tie up large bodies of public land without reasonable probability of future utilization for the purpose contemplated, the facts determined are reported to the department with a recommendation that the right of way be not granted. If a proposed railroad is to approach a stream which may be utilized for power development an examination is made to determine whether the grade proposed will interfere with the future development of power. Where the railroad location is found to conflict with reservoir or dam sites, a careful

study of all the conditions is made to determine whether or not the conflict may be minimized or avoided by relocating the railroad grade and thus preserving the possibility of power development and at the same time permitting the development of transportation facilities.

It frequently appears that the value of lands for power sites is contingent upon future irrigation development, irrigation being recognized as the higher use. Applications for rights of way for irrigation across lands withdrawn for power are therefore carefully considered, and if the projects of which they are a part appear meritorious, a modification of the order of withdrawal to permit the granting of the application is recommended. Pending the construction of the project and the use of the water for irrigation the lands affected are retained in withdrawal, so that if the grantee shall default in construction the power value of the lands may still be considered and controlled. The character of the applications received and the action taken thereon is shown by the accompanying table:

*Applications for rights of way.<sup>a</sup>*

	Railroad.	Irriga- tion.	Water power.	Miscella- neous.	Total.
Pending July 1, 1910.....	1	44	10	3	58
Received July 1, 1910, to June 30, 1911.....	386	655	31	47	1,119
Acted on July 1, 1910, to June 30, 1911.....	277	516	19	39	851
Pending June 30, 1911.....	110	183	22	11	326

<sup>a</sup> First application received from Secretary's office Oct. 11, 1909; first application received from General Land Office Nov. 11, 1909; first application received from Indian Office Dec. 23, 1909.

#### IRRIGATION.

*Carey Act segregations.*—Thirty-one segregation lists prepared under the Carey Act have been referred during the year to the board for report on the water supply available and the general feasibility of the projects contemplated. Five of these lists were recommended for approval unconditionally, and three others, covering projects that involved pumping, were determined to have sufficient water supply for reclaiming the lands considered. Examination of 18 applications showed that under the plan of irrigation proposed by the State the projects contemplated would have an insufficient water supply, and reports were made accordingly. At the close of the year three applications were awaiting a detailed statement by the applicant of the plan of reclamation proposed, and two were under consideration in the Survey.

*Enlarged-homestead designations.*—The designation of additional nonirrigable areas as subject to entry under the enlarged-homestead

act and the refinement of the boundaries of such areas has called for an increasing amount of field investigation during the year. As the larger areas of nonirrigable lands were included in the earlier designations, the amount of additional land designated is relatively small in proportion to the total area open to entry. By the act of Congress of June 17, 1910, the provisions of the original act, somewhat modified, were extended to the State of Idaho, both as regards the enlargement of the entry and as regards nonresidence on lands that are without a sufficient supply of water suitable for domestic purposes. A large area in Idaho has been designated under the general provisions of the act, and detailed investigations of specific tracts for the determination of the water supply available for domestic purposes are in various stages of completion.

The following table indicates the amount designated in each State and summarizes the work of the year:

*Enlarged-homestead designations, fiscal year 1910-1911, in acres.*

State.	Outstanding July 1, 1910.	New designa- tions during fiscal year.	Cancellation during fiscal year.	Outstanding June 30, 1911.
Arizona.....	26,657,280	90,400	157,763	26,589,917
Colorado.....	20,303,720	50,789	.....	20,354,509
Idaho:				
Under sections 1-5 of the act.....	.....	5,347,383	10,545	5,336,838
Under section 6 of the act.....	.....	3,841	.....	3,841
Montana.....	29,686,126	2,167,404	.....	31,853,530
Nevada.....	49,512,960	.....	.....	49,512,960
New Mexico.....	15,883,343	423,332	.....	16,306,675
Oregon.....	9,166,960	2,071,661	24,960	11,213,661
Utah:				
Under sections 1-5 of the act.....	6,654,469	111,311	.....	6,765,780
Under section 6 of the act.....	1,245,818	129,129	.....	1,374,947
Washington.....	3,401,816	1,080	.....	3,402,896
Wyoming.....	16,904,673	634,268	.....	17,538,941
	179,417,165	11,030,598	193,268	190,254,495

*Enlarged-homestead petitions.*—The greater part of the investigations and designations under the enlarged-homestead act have been made in response to petitions for action on specific tracts. During the fiscal year 248 petitions were received and 162 were acted upon. At the close of the year 137 petitions were pending, most of them awaiting reports on uncompleted field examinations. The geographic distribution of these petitions among the 10 States now affected by the act is shown in the table on page 72.

*Action on enlarged-homestead petitions during the fiscal year ending June 30, 1911.*

State.	Out-stand- ing July 1, 1910.	Received during the year.	Designations made.		Refused.	Total acted on.	Pending.
			All.	Part.			
Arizona.....	1	2	1	0	1	2	1
Colorado.....	0	11	6	0	0	6	5
Idaho.....	0	99	12	6	2	20	79
Montana.....	2	59	25	17	21	63	24
Nevada.....	0	0	0	0	0	0	0
New Mexico.....	8	31	18	5	5	28	11
Oregon.....	2	24	8	8	2	18	8
Utah.....	1	5	2	0	1	3	3
Washington.....	2	2	1	0	0	1	3
Wyoming.....	9	15	2	17	2	21	3
	51	248	75	53	34	162	137

## COOPERATION WITH OTHER BUREAUS OF THE DEPARTMENT.

Important action taken during the year to promote the efficient and economical handling of public-land questions has consisted of the adoption of a plan of cooperation between the Geological Survey and the General Land Office. The Land Office has a field force engaged in investigating the validity of entries on public land and in preventing land frauds against the Government. The decision of many of the cases investigated by the field service depends upon the mineral or the water-power value of the land, and the members of the field force make examination on the ground to determine these values. As a rule the Geological Survey has sufficiently definite information with regard to the mineral or water-power value either to obviate the necessity of an examination by the Land Office field service or to facilitate to a considerable degree the making of such examination. This information, in so far as it relates to coal, was placed at the disposal of the Land Office by an agreement that was embodied in a circular of that office, dated July 9, 1910, in which it is provided that before the Land Office shall make field examination of lands involved in certain cases the Geological Survey shall be requested to furnish information as to the tracts involved; that the survey shall thereupon promptly transmit to the Land Office such information as it has on record, together with any suggestions that may be of assistance; that if a field examination in any case is made by a member of the Land Office force a copy of his report will be sent to the Geological Survey, and that if this report differs as to facts or conclusions from the information given by the Survey, the Land Office will suspend action upon the case involved until advice is received from the Survey. On January 27, 1911, the Secretary extended the cooperation thus established so that it covers lands valuable for coal, oil, phosphate, and water power. By these agreements the Land

Office profits by the facts that many examinations that would otherwise be required need not be made and that those which are made can be made more advantageously, and the Survey profits by the information obtained from the reports of the General Land Office field agents.

In order to make even more fully available in the administration of the public lands the fund of information on file in the Survey with regard to the character of the public domain, two further orders have been issued by the Secretary. One dated March 27, 1911, directs that before requesting the survey of a proposed town site or the issuance of patent under a tribal allotment, the Office of Indian Affairs shall call upon the Survey for a report as to whether the tract considered is coal, agricultural, or mineral land and whether it has any value for power or reservoir sites; the other, dated April 27, 1911, directs that before lands included within a national forest are restored to the public domain a report shall be required from the Geological Survey as to whether or not the lands are valuable for coal or have possibilities for the development of power.

Requests for information under these various phases of cooperative agreement and other requests similar in character, but not covered by formal agreement, have during the year numbered 10,747 as to mineral lands and 545 as to lands having power value. Of the former requests 2,722 have been answered and of the latter 369. The distribution of the lands involved in the requests for information regarding mineral character is shown in the following table:

*Requests for information regarding mineral character of public lands.*

State.	Received.	Information furnished.	Pending.
Alaska.....	69	60	9
Arizona.....	125	1	124
California.....	3,461	181	3,280
Colorado.....	165	59	106
Florida.....	28	14	14
Idaho.....	193	142	51
Iowa.....	1	0	1
Louisiana.....	14	14	0
Montana.....	1,783	558	1,225
Minnesota.....	4	2	2
Nebraska.....	6	5	1
Nevada.....	21	2	19
New Mexico.....	708	628	80
North Dakota.....	857	258	<sup>a</sup> 586
Oregon.....	431	28	403
South Dakota.....	301	145	156
Utah.....	1,009	261	748
Washington.....	241	125	116
Wyoming.....	1,330	239	1,091
	10,747	2,722	8,012

<sup>a</sup> 13 cases recalled by General Land Office.

During the year the board has acted on 854 reports of the Land Office field force on the mineral character of lands, involving an

area of 125,800 acres. The table below shows in detail the action taken on these cases. Fifty-two reports as to the water-power value of lands have been considered, leaving 39 pending at the close of the year.

*Action on reports of Land Office field service regarding the mineral character of lands.*

State.	Approved.		Approved in part.	Disapproved.		Pending.		Total.	
	Num-ber.	Area.		Num-ber.	Area.	Num-ber.	Area.	Num-ber.	Area.
Arkansas.....	0			3	360			3	360
California.....	4	400		0		20	6,640	24	7,040
Colorado.....	59	8,180	1	13	1,960	14	1,840	87	11,980
Florida.....	62	7,660		0		3	200	65	7,860
Idaho.....	108	14,840		0		14	1,960	122	16,800
Louisiana.....	4	280		0		10	1,320	14	1,600
Montana.....	54	10,000		4	320	50	7,440	108	17,760
New Mexico.....	28	4,160		1	80	1	120	30	4,360
North Dakota.....	11	1,360		9	1,120	6	840	26	3,320
Oregon.....	20	2,480		0		44	15,420	64	17,900
South Dakota.....	10	1,480		0				10	1,480
Utah.....	35	4,920	3	3	1,280	127	23,560	168	29,760
Washington.....	407	62,920		1	80	2	120	410	63,120
Wyoming.....	8	1,120		6	760	38	4,400	52	6,280
	810	119,800	4	40	5,960	329	63,860	1,183	189,620

DIVISION OF ALASKAN MINERAL RESOURCES.

The work of the division of Alaskan mineral resources was carried on under an appropriation of \$90,000 for "continuation of the investigation of the mineral resources of Alaska." Under this authority, as in previous years, work of the following classes was carried on: Reconnaissance and detailed geologic surveys; special investigations of mineral resources; reconnaissance and detailed topographic surveys; investigations of water resources with reference to the supply available for placer mining; and collection of statistics on mineral production.

PERSONNEL.

The personnel of the division varied greatly during the year on account of transfers of employees to and from other divisions and on account of temporary employment of additional technical and clerical assistants. On July 1, 1910, there were employed in the division 1 geologist in charge, 9 geologists, 7 topographers, 2 engineers, and 3 clerks on annual salaries, 1 topographer on monthly salary, 1 temporary clerical assistant, 2 geologic field assistants, and 26 camp hands. Of the topographers 4 were employed in subdivisional surveys paid for by the General Land Office. (See pp. 82-84.) On June 30, 1911, the personnel of the division included 1 geologist in charge, 12 geologists, 4 topographers, 2 engineers, 1 draftsman, and 3 clerks on annual salaries, 1 geologist on per diem salary, 2 geologic field assist-



ants, and 31 camp hands. During the year there were also employed 1 geologist and 1 clerk, and for short periods several clerical assistants who are not included in the above enumeration.

#### FIELD OPERATIONS IN SEASON OF 1910.

*Allotments and areas covered.*—Twelve parties were engaged in surveys and investigations in Alaska during the season of 1910 for varying periods between April 1 and October 17. Four parties were also employed in subdivisional surveys of public lands. (See pp. 82–84.) In addition to these the geologist in charge spent a part of the summer in Alaska carrying on geologic investigations and visiting field parties.

During the year 13,815 square miles were covered by reconnaissance topographic surveys and 36 square miles by detailed topographic surveys.<sup>1</sup> Detailed geologic surveys were made of 321 square miles and geologic reconnaissance surveys of 8,635 square miles. Most of the geologists also spent considerable time in studying special problems connected with the mineral deposits. The investigation of the water supply in placer districts covered an area of approximately 6,500 square miles and included 69 gaging stations maintained and 429 measurements of stream volume. Fifteen of the thirty mining districts of Alaska which are being developed were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. These figures include the cost of both field and office work, as well as inspection.

#### *Allotments to surveys and investigations in Alaska, 1910–11.*

Southeastern Alaska .....	\$5, 100
Copper River and Susitna region.....	27, 000
Matanuska region.....	9, 600
Upper Yukon basin.....	23, 800
Innoko-Iditarod region.....	14, 100
Northwestern Alaska, including Seward Peninsula.....	10, 400
	<hr/>
	90, 000

The following table shows approximately the amount of money devoted to each class of investigation. It is not possible to give the exact figures, for some of the parties and some of the men carried on two different kinds of work; but this statement will help to elucidate the table given on page 76, which summarizes the complete areal surveys.

<sup>1</sup> Reconnaissance surveys published on a scale of 1 : 250,000 or 1 : 500,000 and detailed surveys on a scale of 1 : 62,500.

*Approximate allotment of funds to different classes of surveys and investigations in Alaska, 1910-11.*

Geologic reconnaissance surveys .....	\$26,500
Detailed geologic surveys.....	11,500
Special geologic investigations.....	2,500
Topographic reconnaissance surveys.....	32,000
Detailed topographic surveys.....	1,600
Investigation of water resources.....	4,000
Collection of statistics of mineral production.....	1,100
Miscellaneous expenditures, including clerical salaries, administration, inspection, instruments, and office supplies and equipment.....	10,200
	<hr/> 90,000

*Allotments for salaries, field and office expenses, 1910-11.\**

Scientific and technical salaries.....	\$29,330
Field expenses, including equipment and supplies.....	51,765
Clerical and other office salaries.....	8,905
	<hr/> 90,000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that a variable amount is expended each year on special investigations that yield results which can not be expressed areally.

*Progress of surveys in Alaska, 1898-1910.<sup>a</sup>*

<sup>a</sup> The areas presented in this table differ somewhat from those previously published. This is due in part to the reclassification of the work and in part to the fact that the areas have been more carefully scaled from the maps than formerly.

<sup>b</sup> In addition to the above, the International Boundary Survey and the Coast and Geodetic Survey have made surveys of parts of Alaska.

*General investigations.*—A. H. Brooks, geologist in charge of the division, was engaged in office work at Washington until August 3, when he proceeded to Alaska, reaching Valdez on August 15. He spent a day in visiting the Cliff mine, and continued his journey to Seward and thence to Knik, spending two days, while en route, in studying the geology in the vicinity of Kern Creek. From Knik Mr. Brooks proceeded to Mr. Martin's camp, which he reached on August 23. He spent the following two weeks in studying the geology of the Matanuska coal field and then returned to Seward. A day at Knik and several days at Seward were utilized in collecting data to be used for planning subdivisional surveys in this general region. Returning, Mr. Brooks reached Washington on September 30.

Of the time spent in the office the geologist in charge has devoted about 30 days to completing the Mount McKinley report, about 46 days to the progress reports for 1909 and 1910, about 25 days to administration of the subdivisional surveys (see pp. 82-84), and the remainder to routine and miscellaneous work.

R. H. Sargent continued his general supervision of the topographic surveys and map compilation, as in the previous year, but his time up to May 1 has been largely devoted to subdivisional surveys of Alaska public lands.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during the latter's absence in the field. He also continued to assist in collecting statistics of the production of precious metals in Alaska.

The office study of problems relating to the stratigraphy of Tertiary coal measures in Alaska was continued by W. W. Atwood during such time as he could spare from his college work. As the correlating of the coal measures of different parts of the Territory must depend on the determination of their fossil plants, Arthur Hollick was employed for six months in a systematic study of the large collection of paleobotanic material already gathered.

*Southeastern Alaska.*—The detailed geologic mapping and study of the mineral resources of the Eagle River region were completed by Adolph Knopf, who mapped a total area of about 125 square miles.

J. W. Bagley, assisted by C. E. Giffin, spent the time from May 6 to June 6 in detailed topographic mapping in the vicinity of Mendenhall River, thus completing the survey of the Eagle River district.

C. W. Wright was employed from July 6 to September 17 in continuing the preparation of a report on the geology and mineral resources of Kasaan Peninsula and Hetta Inlet region. Unfortunately, he was called back to his professional work in Sardinia

before he could complete his report, but he has promised its early completion.

*Copper River and Susitna region.*—D. C. Witherspoon and C. E. Giffin made a topographic reconnaissance survey of the upper Chistochina and Susitna basins, including the Valdez Creek placer district. The party mapped an area of 4,980 square miles.

F. H. Moffit, assisted by B. L. Johnson, made a geologic reconnaissance survey of the southern front of the Alaska Range between the Fairbanks trail and Valdez Creek. Mr. Moffit also made a re-examination of the Chistochina placer district. A geologic reconnaissance map covering about 1,000 square miles was completed, in addition to which the topographic surveys and geologic notes furnished by the Witherspoon party afford a general knowledge of the areal distribution of the principal formations over about 2,000 square miles.

*Prince William Sound and Kenai Peninsula.*—No field work was done in the Prince William Sound and Kenai Peninsula regions other than that accomplished by the geologist in charge (p. 77). U. S. Grant has continued, so far as his collegiate duties permitted, the work of writing a report on the eastern part of Kenai Peninsula.

*Matanuska Valley.*—A detailed geologic survey was made by G. C. Martin, assisted by F. J. Katz and Theodore Chapin, of that part of the Matanuska coal field lying between Moose Creek on the west and Chickaloon River on the east. An area of 196 square miles was surveyed. Mr. Katz, assisted by Mr. Chapin, spent about a week in studying mineral resources of the Willow Creek region.

*Upper Yukon basin.*—No geologic field work was done in the Yukon-Tanana region, but L. M. Prindle spent nine months of the year in preparing a detailed report on the region adjacent to Fairbanks and a more general report on the Fairbanks quadrangle. C. E. Ellsworth and G. L. Parker continued the study of the water resources of the Yukon-Tanana region which was begun in 1907. They began field work at Fairbanks on April 1 and later extended it into the Birch Creek and Fortymile districts. Mr. Parker continued stream gaging in the Fairbanks and Birch Creek districts until September 1, when he went to Nome (p. 79).

J. W. Bagley, topographer, and S. R. Capps, geologist, carried a topographic and geologic reconnaissance survey from the upper Nenana Valley eastward to Delta River, including the Bonnifield placer district and the Nenana coal field. The area surveyed includes 3,135 square miles and is bounded on the south by the crest of the Alaska Range and on the north by the lowlands of the Tanana Valley.

*Innoko-Iditarod region.*—The continued interest in the placer-gold deposits of the Innoko basin, including the newly discovered Iditarod placers, led to an extension of the work previously done in this field.

G. C. Anderson made a topographic reconnaissance survey of an area of 3,200 square miles, extending southward from Ruby Creek, on the Yukon, across the upper Innoko Valley, and including much of the Iditarod basin. A. G. Maddren, assisted by H. E. Birkner, made a geologic reconnaissance survey of about 2,000 square miles of the most important part of the same region, besides investigating the placers of the Innoko and Iditarod districts.

*Northwestern Alaska.*—A geologic and topographic reconnaissance survey was carried from the Koyukuk to Kobuk River by P. S. Smith and H. M. Eakin. The party landed near the mouth of Hogatza River and traveled overland to Dahl Creek, on the Kobuk. (See p. 81.) A contract had been made to have supplies delivered at this point, but their delivery had been prevented by an accident. The party was therefore forced to abandon the plan of extending the survey northward and made its way down the Kobuk by small boat. This, however, gave opportunity for a hasty visit to the newly discovered Squirrel River placer district. An area of 2,500 square miles was covered by geologic and topographic reconnaissance surveys.

Systematic investigations of the water supply of Seward Peninsula have been carried on each year since 1906. The need of investigations in other parts of Alaska made it impossible to detail an engineer to continue this work in 1910. Through the cooperation of mine operators it has been possible to keep up some gaging stations during the open season of 1910. G. L. Parker also spent the period from September 15 to October 18 in Seward Peninsula in collecting the gage readings furnished by several mine operators and in making stream measurements.

*Collection of statistics.*—The work of collecting statistics of the production of gold, silver, and copper begun in 1906 was continued during the year. The progress report for 1909, completed in July, 1910, and published as Bulletin 442, contained preliminary figures showing the mineral production, which were changed but little when the final report was transmitted in October for inclusion in the Survey's annual volume "Mineral resources of the United States" for the calendar year 1909.

#### FIELD OPERATIONS FOR THE SEASON OF 1911.

Under an appropriation of \$100,000 fourteen parties were dispatched to Alaska during the months of March, April, May, and June. One geologic and one topographic party are making reconnaissance surveys in the lower Copper River basin. One topographic party is making detailed surveys of the Port Valdez mining district. Two topographic parties and one geologic party are making reconnaissance and detailed geologic surveys in Kenai Peninsula. One geologic party is making a reconnaissance of the

Yentna placer district in the Susitna basin. Two geologic parties are making reconnaissance surveys of the Circle and Rampart quadrangles. Geologic surveys are being made north of Porcupine River, in cooperation with the International Boundary Commission. One party is to make an exploratory survey of the upper Alatna River basin and of the Noatak Valley. The investigation of the water resources of the Fairbanks, Circle, and Fortymile districts is being continued by two engineering parties. The geologist in charge will leave for Alaska in July to visit Prince William Sound, Kenai Peninsula, and the Fairbanks region.

#### OFFICE WORK.

During the year five bulletins (Nos. 433, 442, 443, 446, and 449) containing results of the work of the Alaska division have been issued. Four bulletins (Nos. 448, 467, 480, and 485) and one professional paper (No. 70) are in press. All these publications contain maps. There have also been issued as publications for sale two reconnaissance maps, those of the Circle and Fortymile (second edition) quadrangles.

The following manuscripts and maps have been submitted for publication:

Geology and mineral resources of the Eagle River region, by Adolph Knopf, including detailed geologic and topographic maps. (Bulletin 502.)

The Sitka mining district, by Adolph Knopf. (Bulletin 504.)

The headwater region of Gulkana and Susitna rivers, with an account of the Chistochina and Valdez Creek placers, by F. H. Moffit, including geologic and topographic reconnaissance maps. (Bulletin 498.)

Coastal glaciers of Prince William Sound and Kenai Peninsula, by U. S. Grant.

Geology and coal fields of the lower Matanuska Valley, by G. C. Martin and F. J. Katz. (Bulletin 500.)

Geology and mineral resources of the Fairbanks quadrangle, by L. M. Prindle and F. J. Katz, including reconnaissance and detailed topographic and geologic maps.

The Bonfield region, by S. R. Capps, including geologic and topographic reconnaissance maps. (Bulletin 501.)

The surface-water resources of Seward Peninsula, by F. F. Henshaw and G. L. Parker, with an account of the geography and geology by P. S. Smith and of the placer mining by A. H. Brooks, including reconnaissance map.

Topographic map of Kasaan Peninsula region; scale, 1:62,500; contour interval, 50 feet. Topography by R. H. Sargent, D. C. Witherspoon, and J. W. Bagley.

Topographic map of Copper Mountain and vicinity; scale, 1:62,500; contour interval, 50 feet; by R. H. Sargent.

The following reports are in hand:

Geology and ore deposits of Kasaan Peninsula and the Copper Mountain region, Prince of Wales Island, by C. W. Wright, including detailed geologic and topographic maps.



Geology of Glacier Bay and Lituya region, by F. E. Wright and C. W. Wright, including geologic reconnaissance maps.

Geology and mineral resources of the southern part of Kenai Peninsula, by U. S. Grant and D. F. Higgins, including geologic reconnaissance maps.

The Koyukuk-Chandalar gold region, by A. G. Maddren, including geologic and topographic reconnaissance maps.

The Iditarod-Innoko region, by A. G. Maddren, including geologic and topographic reconnaissance maps.

Geology of the Nome and Grand Central quadrangles, by F. H. Moffit and Philip S. Smith, including detailed geologic map.

The following topographic maps have been completed during the year and are in process of publication as illustrations to reports:

Map of Eagle River region, by J. W. Bagley; scale, 1:62,500; contour interval, 50 feet.

Reconnaissance map of headwater region of Gulkana and Susitna rivers, by D. C. Witherspoon and C. E. Giffin; scale, 1:250,000; contour interval, 200 feet.

Reconnaissance map of Bonnifield region, by J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

#### GEOLOGIC RESULTS.

Mr. Moffit's studies in the upper Gulkana and Susitna basins show that the auriferous slates of this region are of Mesozoic age and that the mineralization is probably genetically related to intrusive granites and diorites. In the Matanuska region Mr. Martin and Mr. Katz have divided the Eocene, formerly mapped as a unit, into three formations. They have also found extensive strata of fossiliferous Cretaceous and Jurassic rocks in this field. Their studies have shown that there is a zone of intense deformation along the southern margin of the Talkeetna Mountains and that pronounced disturbances, including a large number of thrust faults, took place in post-Eocene time. Mr. Maddren had found that the gold of the Iditarod placer district is closely associated with intrusive rocks. In the Bonnifield region Mr. Capps has been able to divide the crystalline schists into two groups—an older, probably of pre-Ordovician age, made up chiefly of metamorphosed sediments, and a younger, composed largely of altered igneous rocks, probably of Paleozoic age. He has also found some evidence that the heavy terrace gravel deposits of this district may be preglacial. Mr. Smith and Mr. Eakin have traced the Cretaceous rocks of the lower Koyukuk into the Kobuk Valley. They have also found that the Squirrel River placers, in this region, occur in association with metamorphic rocks similar to those of the Seward Peninsula. Mr. Hollick's studies of the coal-measure floras are not yet complete. It appears probable, however, that the coal-bearing rocks, hitherto classed as Kenai, may on account of their contained floras be divided into three groups, of which the oldest will be Cretaceous, the middle true Kenai (Eocene), and the youngest post-Eocene.



## SURVEY OF PUBLIC LANDS.

*Plans, personnel, etc.*—An item in the sundry civil act approved June 25, 1910, provided "for the survey of the lands in the United States in the District of Alaska, \$100,000." In accordance with instructions the Director of the Geological Survey, on June 25, 1910, submitted plans for the surveys authorized by this item to the Secretary of the Interior through the Commissioner of the General Land Office. These plans were approved by the Commissioner and by the Secretary on June 29. In a letter dated June 29 the Director instructed the geologist in charge of the division of Alaskan mineral resources to put the plans into execution.

The approved plans authorized the following surveys:

1. The astronomic determination of the latitude, longitude, and azimuth in the vicinity of the initial point of the proposed surveys, near Fairbanks.

2. Time permitting, the astronomic determination of latitude, longitude, and azimuth at another point near the mouth of Tanana River, which might be used as a reference point for future surveys in this district.

3. The establishment of a triangulation system in the vicinity of Fairbanks, by which the location of land lines and corners could be accurately determined and which could also be so developed as to permit extensions into other areas where subdivisional surveys are needed.

4. The extension of a base and meridian from the initial point near Fairbanks.

5. The survey of such township exteriors as were considered desirable.

6. Time permitting, the subdivision of these townships.

7. The making of reconnaissance surveys in the Copper River, Seward, and Matanuska regions to obtain information on which to plan surveys in these provinces.

As provided in the plans submitted, the Superintendent of the Coast and Geodetic Survey detailed the engineers required to make determinations of latitude, longitude, and azimuth at Fairbanks and at the mouth of the Tanana.

R. H. Sargent, topographer, was put in charge of the field parties at Fairbanks. C. L. Nelson, W. N. Vance, and S. G. Lunde, topographers, were detailed to assist Mr. Sargent. In addition to these four engineers, who were detailed from the permanent staff of the Geological Survey, four chainmen and one recorder accompanied the party from Seattle. At Fairbanks 21 other men were engaged as rodmen, axmen, packers, cooks, and in other minor capacities.

The personnel of the two line parties and the triangulation party were as follows:

Line parties:

1 engineer in charge.  
4 chainmen.  
2 flagmen.  
3 axmen.  
1 cook.  
1 teamster.

Triangulation party:

1 engineer in charge.  
1 axman.  
1 packer.  
1 cook.  
1 recorder.

Mr. Sargent was directed, after starting the work at Fairbanks, to proceed by trail to Valdez and make the investigations along this route that were necessary to procure information required for planning future work in this field.

Mr. Brooks undertook similar investigations in the northeastern part of Kenai Peninsula and in the Matanuska region.

Although the money was not available for these surveys until July 1, the parties sailed from Seattle on July 5, arrived at Fairbanks on July 22, and began work on the following day. Mr. Sargent organized the work at Fairbanks and then returned to the coast by way of the Valdez trail, making investigations on the way for land surveys in this district. Mr. Brooks spent a month in the Kenai Peninsula and Seward Peninsula, devoting a part of the time to collecting information to be used in planning land surveys in this district. The other parties continued work in the Fairbanks district until about the middle of October. The office work was completed after the return of the field parties, and on May 15, 1911, the resulting plats and notes were transmitted to the Commissioner of the General Land Office. The total expenditure for this work was \$35,132.27.

*Astronomic determinations.*—An astronomic determination of latitude, longitude, and azimuth was made at a station near Fairbanks by the Coast and Geodetic Survey. A similar determination was made at Tanana, a settlement on the west bank of the Yukon, at the mouth of Tanana River. This work was done in accordance with the approved plans and with an agreement made between the Secretary of the Interior and the Secretary of Commerce and Labor, under date of July 5, 1910. The Superintendent of the Coast and Geodetic Survey transmitted the results of the final computations of these observations on February 6, 1911.

*Triangulation.*—A base line was measured and a system of triangulation was established, the geodetic position of which was based on the astronomic observations. This triangulation not only checked the line surveys, but can also be extended into adjacent parts of the

Tanana Valley to provide points from which land surveys of important areas may be made in the future. By this means the projection of long standard parallels and guide meridians through areas of no commercial importance will be avoided.

The primary triangulation stations are marked by bronze tablets, furnished by the General Land Office, firmly set in concrete or solid rock. In preparation for the future expansion of the triangulation system six signals have been constructed on prominent hills in the Tanana Valley.

*Summary of triangulation.*

Base line measured.....	feet	13, 876, 674
Primary stations occupied.....		12
Secondary stations occupied.....		15
Points intersected .....		3
Signals constructed .....		6

*Line work.*—The line work consisted chiefly of extending base and meridian lines and the survey of township exteriors. Some section lines and a few meanders were also run. The geodetic position of the initial point was determined by triangulation. It seemed desirable not to attempt the sectionizing of the townships until the matter of the rights of the homesteaders had been settled.

*Summary of line surveys.*

	Miles.
Principal meridians.....	23. 7
Base line.....	18
Township exteriors.....	43. 7
Section lines.....	11. 8
Meanders .....	11. 7
	<hr/>
	108. 9

It was impossible to ship iron posts to Fairbanks in time to make them available for the season's work. Wooden posts were therefore set, properly inscribed and witnessed in accordance with the regulations of the General Land Office.

The number of corners set was as follows:

*Corners set.*

Initial point.....	1
Township corners.....	7
Standard township corners.....	3
Closing township corners.....	3
Section corners.....	76
Quarter corners.....	86
Meander corners.....	8
Witness corners.....	8

## DIVISION OF MINERAL RESOURCES.

The work of the division of mineral resources consists primarily of the preparation of the annual report on the mineral resources of the United States. This work was organized under the act of August 7, 1882, authorizing the United States Geological Survey to procure statistics in relation to mines and mining. Since that time the reports have appeared annually, except that the data for 1883 and 1884 were published in one volume and those for 1889 and 1890 in one volume. Since 1907, on account of the increase in the quantity of material available for publication, it has been necessary to publish the report in two volumes. At first only the more important lines of inquiry were taken up and the statistics were largely estimates. As the work progressed and the mineral industries increased in importance the necessity for more accurate statistics became more apparent, the character of the publication changed, and for many years this report has been an annual census of the mineral industries.

The plan pursued in the first report—that of publishing chapters devoted to each mineral, prepared by or under the supervision of some one who makes a special study of the subject, rather than chapters devoted to each State—has never been changed. The practice of publishing in pamphlet form each chapter for distribution to those especially interested in the subject has been carried out from the second report. This practice permits early publication and also makes for economy in printing, as generally correspondents, especially producers, are interested in only one or two subjects. The publication of separate chapters also permits the information on any particular subject to be distributed as soon as it is ready. The complete report can be published only after the last chapter is ready, but all the information contained in the report has already been given to the public, some of it months before.

In the desire to carry out the section of the organic act of the Survey providing for the examination of the mineral resources and products of the national domain, the study of the occurrence and utilization of the economic minerals of the country has been taken up in addition to the compilation of the statistics of production. As a result of this work maps have been published showing the coal fields, the oil and gas fields, and the iron-ore regions of the United States, and similar maps showing the distribution of other minerals are in preparation. The policy is to make the volumes of "Mineral resources" a cyclopedia of information relative to the sources of our mineral production, including a study of the reserves available for future use, and a discussion of their application to the needs of man.

Cooperation between the United States Geological Survey and the State geological surveys in collecting mineral statistics in many of the States was resumed for 1910. For 1909 it had been suspended on account of the cooperative arrangement made by the Survey with the Bureau of the Census. This cooperation with the State surveys has the primary object of saving labor for the producers, who can make one report that will serve for both organizations. A secondary result is that by this cooperation the statistics of production obtained by the State and Federal surveys are believed to be more accurate and are in exact agreement. On the whole this plan has been satisfactory and its continuance is believed to be to the advantage of all concerned.

During the fiscal year the work of the division consisted of the preparation of reports on mineral resources of the United States for the calendar years 1909 and 1910. The statistics for 1909 were collected in cooperation with the Bureau of the Census. In accordance with the agreements between the two bureaus, approved by the Secretary of Commerce and Labor and the Secretary of the Interior, the field work of collecting the statistics was done by the Bureau of the Census by personal visits of a large force of agents. It was thought that this plan would greatly expedite the work. Experience showed, however, that it took very much longer to get the data in this way than it would have taken by correspondence, the usual method pursued by the Survey. The following table gives the estimated percentage of schedules returned at the close of the fiscal years 1909, 1910, and 1911 for some of the more important products, the period covered by the returns being the preceding calendar year:

*Percentage of schedules returned from producers at end of fiscal years 1909, 1910, and 1911.*

Industry.	June 30, 1909.	June 30, 1910.	June 30, 1911.
Building stone.....	97	26	90
Clay working.....	98	35	95
Coal.....	98	26	99
Coke.....	100	15	100
Iron ore.....	100	24	100
Natural gas.....	90	43	80
Quicksilver.....	99	33	100

In consequence of the tardy receipt of the schedules for 1909 the report for that year, to be published in two volumes, has not yet appeared, though both parts are well advanced toward completion in the hands of the printer. At the beginning of the present calendar year preliminary estimates of the production in 1910 of coal, cement, petroleum, gold, silver, copper, lead, and zinc were given

to the public through the press. Advance preliminary statements of the production of copper, lead, and zinc in 1910 have also been published.

Advance chapters from the report for 1910 have been published as follows: Asbestos, Fuller's earth, Graphite, Mica, Monazite, Potash salts, and Quartz and feldspar. The following were in the hands of the printer at the close of the year: Chromic iron ore, Coke, Gypsum, Sand-lime brick, and Talc and soapstone.

The cooperative plan carried on between this division and the division of geology for several years was continued to the mutual advantage of both. By this plan geologists are assigned to supervise the compilation of the statistical data relating to certain mineral products and to prepare the reports on these products. This plan gives to the statistical work the benefit of the cooperation of the geologist trained in economic work and gives to the geologist the opportunity to study the industrial and commercial conditions which affect the demand for the minerals. This method is also economical because the work for the division of mineral resources does not require the entire time of the geologist, but allows him opportunity to engage in his scientific pursuits, thus permitting the division to pay simply for the actual cost of its work.

The number of permanent employees in Washington who devote their entire time to the work of the division is 28. In addition 13 members of the division of geology devote a portion of their time to the work of this division and 7 persons are employed in the offices of the Survey outside of Washington, making a total of 48 persons engaged on the work under appointments from the Secretary of the Interior.

Three offices are maintained in the West, at Denver, Salt Lake City, and San Francisco, where the local representatives gather statistics and other data for the division and disseminate information.

E. W. Parker continued as administrative head of the division, and Waldemar Lindgren exercised supervision over the preparation of chapters on metalliferous ores. In addition to his administrative duties Mr. Parker has prepared reports on the production of coal, the manufacture of coke, and the briquetting industry for 1909. E. S. Bastin prepared reports on quartz and feldspar and graphite; E. F. Burchard on barytes and strontium, cement, fluorspar, and cryolite, glass sands and other sands, gypsum, iron ore, manganese and maniferous ores, mineral paints, and stone; B. S. Butler on copper; D. T. Day on asphaltum and bituminous rock, and natural gas and petroleum; J. S. Diller on asbestos and talc and soapstone; J. P. Dunlop on secondary metals; F. L. Hess on antimony, arsenic, bismuth, nickel, cobalt, and steel-hardening metals; H. D. McCaskey on gold, silver, and copper in the Central States and the Eastern States;



Jefferson Middleton on clay, clay-working industries, fuller's earth, and sand-lime brick; W. C. Phalen on abrasive materials, aluminum and bauxite, bromide, potash salts, sodium salts, and sulphur and pyrite; C. E. Siebenthal on lead and zinc; D. B. Sterrett on gems and precious stones, mica, and monazite and zircon; F. B. Van Horn on phosphate rock, and C. G. Yale on borax and magnesite. A few unimportant changes in the assignments have been made for the fiscal year 1912. In addition to his reports Mr. McCaskey has general supervision of the offices of this division in the Western States. These offices are under the direct charge of the following persons: Denver, C. W. Henderson; Salt Lake City, V. C. Heikes; San Francisco, C. G. Yale.

#### DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the chemical laboratory 440 quantitative analyses and 838 qualitative determinations, chiefly of minerals sent in for examination by persons not connected with the survey, were reported during the year.

G. F. Becker has been engaged chiefly in studying the bearing of radioactivity upon geologic phenomena and has practically completed an investigation of the cooling of a radioactive earth. As an incident to this investigation he has discovered a whole system of novel and extremely efficient formulas for mechanical quadratures. He has also completed a biographic notice of Samuel Franklin Emmons for the American Institute of Mining Engineers.

F. W. Clarke has been engaged mainly in revising the Data of Geochemistry, the republication of which has been made desirable by the large use of this bulletin in educational institutions and by professional students of geology.

Chase Palmer made a number of analyses of rocks and minerals and continued his study of the surface waters of the United States.

R. C. Wells, besides assisting in the analytical work of the chemical laboratory, collaborated with C. E. Van Orstrand, of the physical laboratory, in his experiments on the diffusivity of metals by electroplating the metallic junctions. His research work consisted of a study of the fractional precipitation of metallic carbonates with reference to problems of ore deposition. Special determinations concerning ore deposition were made for several of the Survey geologists. The following papers by Mr. Wells were published during the year: "The sensitiveness of the colorimetric estimation of titanium," "The rôle of hydrolysis in geological chemistry," and, jointly with F. L. Hess, a paper describing an occurrence of the mineral strüverite and its analysis by a new method.

George Steiger gave most of his time to routine quantitative analyses. He represented the laboratory at the meetings of the com-



mittee to award contracts for supplies for 1911 and 1912 and made a study of the composition of muscovite and prepared a short paper on the subject.

W. T. Schaller devoted his time largely to routine analyses consisting of qualitative chemical and mineralogical determinations, as well as quantitative rock analyses. He published descriptions of the minerals barbierite and mosesite and analyzed and described for publication three additional new minerals—beaverite, from Utah; hinsdalite, from Colorado; and ferritungstite, from Washington. He also analyzed and described a number of rare minerals, among them pucherite, bismite, and cuprodescloizite, from California, and thaumasite, plumbojarosite, corkite, and variscite, from Utah. Crystallographic studies were made on ferberite from Colorado, wurtzite and variscite from Utah, and several minerals from Hawaii. A new silicate mineral from New Jersey and a new copper phosphate from Virginia were investigated, and a theoretical study of the rutile group was continued and extended. The relations of podolite to dahllite, of stelznerite to antlerite, and of the members of the alunite group were investigated. Mr. Schaller visited mineral collections in New York City and in Dover and Trenton, N. J., making a special study of the California tourmalines with a view to finishing a paper on that subject. He published the following papers during the year:

Ludwigite from Montana: *Am. Jour. Sci.*, 4th ser., vol. 30, 1910, p. 146.

Mosesite, a new mercury mineral from Terlingua, Tex. [with F. A. Canfield and W. F. Hillebrand]: *Idem*, p. 202.

The probable identity of podolite with dahllite; the identity of stelznerite with antlerite: *Idem*, p. 309.

Barbierite, a monoclinic soda feldspar: *Idem*, p. 358.

Natramblygenite, a new mineral: *Am. Jour. Sci.*, 4th ser., vol. 31, 1911, p. 48.

Thaumasite from Beaver County, Utah [with B. S. Butler]: *Idem*, p. 131.

Bismuth ochers from San Diego County, Cal.: *Jour. Am. Chem. Soc.*, vol. 33, 1911, p. 162.

Axinit von Californien: *Zeitschr. Kryst. Min.*, vol. 48, 1910, p. 148.

Die chemische Zusammensetzung von Jamesonit und Warrenit: *Idem*, 1911, p. 562.

Krystallographische Notizen uber Albit, Phenakit und Neptunit: *Idem*, 1911, p. 550.

Wismutocker [with F. L. Ransome]: *Idem*, 1910, p. 16.

Die Brechungsexponent von Kanada-Balsam: *Centralbl. Min.*, 1910, No. 13, p. 390.

H. A. Lepper was employed as laboratory assistant from July 18 to October 18, 1910. His time was given exclusively to the analysis of phosphate rocks sent in by Eliot Blackwelder and R. W. Richards.

J. G. Fairchild was appointed assistant chemist in the survey and began his duties in the chemical laboratory on November 1. His time was mostly given to the analyses of phosphates, with occasional analyses of minerals and rocks. He also critically investigated methods for the determination of phosphoric acid.

In the physical laboratory C. E. Van Orstrand has continued experiments on the elasticity and diffusivity of metals, the experiments on diffusivity having been carried on in cooperation with Mr. Wells, of the chemical laboratory, and Dr. F. P. Dewey, assayer in the office of the Director of the Mint at Washington. Theoretical work supplementing these investigations has been continued throughout the year. Some time has been given to the preparation of certain mathematical tables which are of general application, but of particular value to the student of geophysics. In this connection a complete ten-place table of the circular sines and cosines to radian argument has been begun, and two tables have been completed. The first consists of 16,000 five-place values of the natural logarithm and the second consists of 2,500 five-place values to radian argument of the circular tangent and cotangent and their logarithms. The last two tables are to be included in the revised edition of "Smithsonian mathematical tables of hyperbolic functions."

### TOPOGRAPHIC BRANCH.

#### ORGANIZATION.

The organization of the topographic branch remained the same as at the close of the last fiscal year and is as follows:

Chief geographer, R. B. Marshall.

Atlantic division, Frank Sutton, geographer in charge.

Central division, W. H. Herron, geographer in charge.

Rocky Mountain division, Sledge Tatum, geographer in charge.

Pacific division, T. G. Gerdine, geographer in charge.

Inspectors of topography: J. H. Renshawe, geographer; W. M. Beaman and F. E. Matthes, topographers.

#### PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 1 topographer, 3 assistant topographers, 21 junior topographers, and 2 draftsmen. It was reduced 26 by transfers, resignations, etc. With these changes the technical force now includes 1 chief geographer, 10 geographers, 47 topographers, 44 assistant topographers, 51 junior topographers, and 9 draftsmen—a total of 162. In addition to the above, 68 technical field assistants were employed during a whole or a part of the field season. One geographer and 7 topographers are on leave without pay.

#### PUBLICATIONS.

The work of the topographic branch is represented by 11 publications issued during the year, namely, Bulletins 434, 437, 440, 441, 453, 457, 459, 460, 461, 462, and 463, titles and brief summaries of which are given on pages 27–30. At the end of the year Bulletins

**PHIC SURVEYS**

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458, 464, 468, 469, 472, 473, 476, and 477 (Results of spirit leveling in Arkansas, Louisiana, Mississippi, New Mexico, Texas, North Dakota, South Dakota, Kansas, Nebraska, Ohio, and West Virginia, respectively) were at the Government Printing Office nearly ready for publication. In addition, the manuscripts for 9 bulletins were assembled near the close of the fiscal year and transmitted to the editor for publication as Bulletins 466 (Idaho-Washington boundary line), 481 (Results of spirit leveling in California), 482 (Results of spirit leveling in Montana), 486 (Results of spirit leveling in Colorado), 487 (Results of spirit leveling in Idaho), 488 (Results of spirit leveling in Nevada), 489 (Results of spirit leveling in Utah), 493 (Results of spirit leveling in Illinois), and 496 (Triangulation and traverse results for 1909-10). During the year 83 topographic maps were issued, the titles of which are given on page 35.

#### GENERAL OFFICE WORK.

In the triangulation and computing section progress maps were kept up to date and new ones were compiled when necessary; field notes in connection with horizontal and vertical control work were catalogued and copied; instructions relating to triangulation, traverse, levels, and the adjustment of instruments were prepared; and work was done in connection with a committee appointed to determine the areas of the several States and of Alaska.

#### SUMMARY OF RESULTS.

The condition of topographic surveys to July 1, 1911, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 23,272 square miles, making the total area surveyed to date in the United States 1,131,037 square miles, or about 37 per cent of the entire country. In addition, 6,460 square miles of revision or resurvey were completed, making the total area of actual surveys for the season 29,732 square miles.

Triangulation stations to the number of 99 were occupied and permanently marked. There were run 3,837 miles of primary traverse, in connection with which 467 permanent marks were set. In the course of the work 22,350 square miles were covered by primary control.

In connection with these surveys 5,998 linear miles of primary levels were run, making the total amount of primary and precise levels run since the authorization of this work by Congress, in 1896, 230,430 miles.

The area covered by topographic surveys in Alaska during the fiscal year 1910-11, as reported in detail on pages 76-79, was 13,851 square miles—36 for publication on the scale of 1:62,500 and 13,815 for publication on the scale of 1:250,000.

Topographic surveys were also carried on in Hawaii, the area mapped during the fiscal year being 224 square miles, part for publication on the scale of 1:31,680 and part for publication on the scale of 1:62,500, making the total area in Hawaii surveyed to date 598 square miles.

*Present condition of topographic surveys of the United States and new areas surveyed in 1910-11.*

State or Territory.	New area surveyed in 1910-11.	Total area surveyed to June 30, 1911.	Percentage of total area of State surveyed to June 30, 1911.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	
Alabama.....	356	18,639	36
Arizona.....	958	64,436	57
Arkansas.....	245	21,043	39
California.....	6,412	99,326	63
Colorado.....	993	42,744	41
Connecticut.....		4,965	100
Delaware.....		1,008	43
District of Columbia.....		70	100
Florida.....		1,821	3
Georgia.....		17,337	29
Idaho.....	811	19,009	23
Illinois.....	1,011	11,093	20
Indiana.....	100	3,041	8
Iowa.....	328	10,776	19
Kansas.....		64,159	78
Kentucky.....	666	17,142	42
Louisiana.....		8,283	17
Maine.....	470	8,271	25
Maryland.....	333	11,104	90
Massachusetts.....		8,206	100
Michigan.....	193	5,117	9
Minnesota.....	719	4,301	5
Mississippi.....	38	1,834	4
Missouri.....	351	35,043	52
Montana.....	1,075	53,723	37
Nebraska.....		25,974	34
Nevada.....	200	50,675	46
New Hampshire.....		3,380	36
New Jersey.....		8,224	100
New Mexico.....	1,672	33,579	27
New York.....	698	40,919	83
North Carolina.....		17,661	34
North Dakota.....		9,716	14
Ohio.....	1,504	28,823	70
Oklahoma.....	14	38,691	55
Oregon.....	391	18,670	19
Pennsylvania.....	794	23,607	52
Rhode Island.....		1,248	100
South Carolina.....		5,640	18
South Dakota.....	638	18,594	24
Tennessee.....	448	20,793	49
Texas.....		66,807	25
Utah.....	480	67,905	79
Vermont.....	139	3,676	38
Virginia.....		29,980	70
Washington.....	840	21,594	31
West Virginia.....	50	24,170	100
Wisconsin.....		11,789	21
Wyoming.....	345	26,371	27
Hawaii.....	23,272 224	1,131,037 598	..... .....

ATLANTIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Alabama, Maine, Maryland, Mississippi, New York, North Carolina, Pennsylvania, Tennessee, Vermont, and West Virginia. This work comprised the survey of 11 quadrangles and 1 special area and the resurvey or revision of 7 quadrangles and 2 special areas. In addition, 11 quadrangles were partly surveyed and 6 were partly resurveyed. The total new area mapped was 3,326 square miles—3,148 for publication on the sale of 1:62,500, 80 for publication on the scale of 1:31,680, and 98 for publication on the scale of 1:24,000. The area resurveyed was 1,753 square miles—1,710 for publication on the scale of 1:62,500, 40 for publication on the scale of 1:125,000, and 3 for publication on the scale of 1:12,000. In connection with this work 1,541 miles of primary levels were run and 351 permanent bench marks were established. Profile surveys were also made of 9 rivers, the total distance traversed being 439 miles, and in connection with this work areas aggregating 117 square miles were mapped for publication on the scale of 1:24,000.

Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of Georgia, Florida, Maine, Pennsylvania, Tennessee, New York, Virginia, West Virginia, and Delaware. The total area covered by the primary control was about 4,450 square miles, of which 4,000 were controlled by primary traverse, 1,263 miles being run and 188 permanent marks set. Thirty-one triangulation stations were occupied and 24 were marked. The result of this work was to make control available in thirty-one 15-minute quadrangles.

Topographic surveys in Atlantic division from July 1, 1910, to June 30, 1911.

States.	Contour interval.	For publication on scale of -				Total area surveyed.	Primary levels.		Primary traverse.	
		1:24,000.	1:62,500.		1:125,000.		Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	New.	Resurvey.	Resurvey.					
	<i>Fect.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>	
Alabama.....	10-20	61	295			356	11			
Maine.....	20	37	433			470	38	8		
Maryland.....	5-20		333			1 336	74	28		
Mississippi.....	20		38			38	50	12		
New York.....	20		698	218		916	245	50	84	11
North Carolina.....	100				5	5				
Pennsylvania.....	20		794			794	41	12		
Tennessee.....	5-20-100		368	101	35	2 584	329	57	478	50
Vermont.....	20		139			139	55	11		
West Virginia.....	20-50		50	1.391		1,441	327	76		
Delaware.....									139	24
Florida.....							278	73	368	84
Georgia.....							93	24	65	6
Virginia.....									129	13
		98	3,148	1,710	40	5,079	1,541	351	1,263	188

1 3 square miles resurveyed in Maryland for publication on scale of 1:12,000.  
2 80 square miles surveyed in Tennessee for publication on scale of 1:31,680.



## DETAILS OF WORK BY STATES.

*Alabama.*—Under an allotment of \$800 made by the State geologist, which was met with an equal amount by the United States Geological Survey, the mapping of the Fayette special area, comprising 61 square miles in Fayette County, was completed by R. H. Reineck, for publication on the scale of 1:24,000, with a contour interval of 10 feet. In addition to the cooperative work, the survey of the Seale quadrangle, in Russell and Lee Counties, was completed by R. D. Cummin and Olinus Smith, the area mapped being 252 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area J. M. Rawls and A. F. McNair ran 11 miles of primary levels. (See also pp. 95–96.)

*Delaware.*—For the control of the Seaford and Georgetown quadrangles, in Sussex County, E. L. McNair ran 139 miles of primary traverse and set 24 permanent bench marks.

*Florida.*—The primary control of the Palatka, Interlachen, Hawthorne, and Starke quadrangles, in Bradford, Clay, St. John, Putnam, and Alachua counties, was completed. For this control J. B. Metcalfe and C. W. Arnold ran 278 miles of primary levels and established 73 permanent bench marks; C. B. Kendall, J. H. Wilson, and S. E. Taylor ran 368 miles of primary traverse and set 84 permanent marks.

*Georgia.*—For the control of the White Plains, Eatonton, Greensboro, and Milledgeville quadrangles, in Greene, Hancock, Morgan, Oconee, Oglethorpe, Putnam, and Taliaferro Counties, J. B. Metcalfe and C. W. Arnold ran 93 miles of primary levels and established 24 permanent bench marks; for the control of the White Plains quadrangle C. B. Kendall ran 65 miles of primary traverse and set 6 permanent marks.

*Maine.*—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted \$4,500 and the United States Geological Survey allotted a like sum. In addition, an allotment of \$5,000 was made by the State for river-profile surveys. The survey of the Livermore quadrangle, in Androscoggin, Franklin, Kennebec, and Oxford counties, was completed by Hersey Munroe and Charles Hartmann, jr., the area mapped being 214 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Buckfield and Bryants Pond quadrangles, in Franklin, Oxford, and Androscoggin counties, was begun by Messrs. Hartmann and Munroe, the area surveyed being 219 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Livermore and Buckfield quadrangles, Mr. Hartmann and H. P. Kilby ran 38 miles of primary levels and established 8 permanent bench marks. The survey of Dead

River and Sandy River, in Somerset and Franklin counties, was begun by Jay De Puy, the distance traversed being 214 miles, and an area of 37 square miles being topographically mapped, for publication on the scale of 1:24,000, with contour intervals of 5 and 20 feet. The survey of Piscataquis, Pleasant, Schoodic, and Sebec rivers, in Penobscot and Piscataquis counties, and of Silver Lake and Houston Pond, in the same counties, was begun by Olinus Smith, the distance traversed being 183 miles. For the control of the Bethel and Bryants Pond quadrangles, in Oxford County, E. L. McNair occupied 3 triangulation stations.

*Maryland.*—For the continuation of cooperative topographic surveys in Maryland the State geologist allotted \$2,000, which was met with a like sum by the Geological Survey. The survey of the Hagerstown quadrangle, in Washington and Frederick Counties, Md., and Franklin County, Pa., and of the Williamsport quadrangle, in Washington County, Md., Berkeley County, W. Va., and Franklin County, Pa., was completed by J. H. Wheat, R. L. Harrison, Olinus Smith, and R. A. Kiger, the total area mapped being 363 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of this area 40 square miles lies in Pennsylvania and 50 square miles lies in West Virginia, and the mapping of those portions of the quadrangles was paid for from funds of the respective States. For the control of the Williamsport quadrangle, C. H. Semper ran 17 miles of primary levels and established 6 permanent bench marks in Washington County, Md., 7 miles of primary levels and 3 permanent bench marks in Berkeley County, W. Va., and 3 miles of primary levels and 1 permanent bench mark in Franklin County, Pa. The mapping of the Indian Head and Nanjemoy quadrangles, in Charles County, was begun by R. L. Harrison, the area mapped being 60 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these quadrangles, A. F. McNair and C. W. Arnold ran 42 miles of primary levels and established 13 permanent bench marks. In addition to the cooperative work in Maryland a special resurvey was made along Potomac River between Lock No. 10 and Great Falls, in the District of Columbia, Montgomery County, Md., and Fairfax County, Va. The area mapped was 3.3 square miles, for publication on the scale of 1:12,000, with a contour interval of 5 feet. This work was done by R. T. Evans, E. P. Davis, C. E. Cooke, and R. L. Harrison. D. H. Baldwin ran 15 miles of primary levels and set 9 permanent bench marks.

*Mississippi.*—The survey of the Iuka quadrangle, in Tishomingo County, Miss., and Colbert and Lauderdale Counties, Ala., was continued by J. F. McBeth, the area mapped being 81 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area J. B. Metcalfe and J. M. Rawls

ran 50 miles of primary levels and established 12 permanent bench marks. Of the Iuka quadrangle, 43 square miles lies in Alabama.

*New York.*—The State engineer and surveyor of New York allotted \$10,000 for the continuation of cooperative topographic surveys in the State and the Federal Survey allotted a like sum for the same purpose. The survey of the New Berlin, Canton, and McKeever quadrangles, in Otsego, Chenango, Madison, St. Lawrence, Herkimer, Oneida, and Lewis counties, was completed by C. E. Cooke, R. C. McKinney, J. I. Gayetty, S. P. Floore, J. H. Lee Feaver, J. F. McBeth, and H. L. Dodge, the total area mapped being 609 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The mapping of the Lowville quadrangle, in Lewis County, was begun by J. M. Whitman, S. P. Floore, and J. H. Lee Feaver, the area mapped being 89 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the New Berlin, McKeever, and Lowville quadrangles and of the No. 4 quadrangle, in Lewis and Herkimer counties, C. H. Semper, K. E. Schlachter, and James Rayburn ran 245 miles of primary levels and established 50 permanent bench marks, and D. H. Baldwin ran 84 miles of primary traverse and set 11 permanent marks. Revision of culture was completed on the Rochester quadrangle, in Monroe County, by C. E. Cooke, the area revised being 218 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

*North Carolina.*—(See Tennessee-North Carolina, pp. 97–98.)

*Pennsylvania.*—The Topographic and Geological Survey Commission of Pennsylvania allotted \$5,183 for the continuation of the cooperative topographic survey of the State, and the United States Geological Survey allotted a like sum for the same purpose. The survey of the McCalls Ferry, Quarryville, and Hilliards quadrangles, in York, Lancaster, Chester, Venango, Butler, and Mercer counties was completed, and that of the Mercer and Stoneboro quadrangles, in Mercer and Crawford counties, was begun; the total area mapped being 754 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by Duncan Hannegan, R. C. McKinney, J. H. Renshawe, R. A. Kiger, Robert Muldrow, J. M. Whitman, and W. N. Vance. For the control of these areas and of the Lancaster and New Holland quadrangles, in Lancaster County, C. H. Semper, James Rayburn, and Howard Mellinger ran 38 miles of primary levels and established 11 permanent bench marks. For the control of the Winter, Somerset, Ligonier, Windber, and Stahlstown quadrangles, in Somerset and Westmoreland counties, George T. Hawkins and J. B. Metcalfe occupied and marked 13 triangulation stations. The survey of the Pennsylvania portions of the Hagerstown and Williamsport quad-

rangles (the greater part of which lies in and is reported under Maryland), in Franklin County, was also completed, the area mapped being 40 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 3 miles of primary levels were run and one permanent bench mark was set.

*Tennessee.*—The North Fork of the Forked Deer River drainage commission and the Rutherford Fork of Obion River drainage commission allotted, through the State geologist, the sums of \$1,000 and \$1,250, respectively, for cooperative topographic surveys of those rivers and the United States Geological Survey made like allotments for the same purpose. Areas of 37 square miles in Gibson County, on North Fork of Deer River, and of 43 square miles on Rutherford Fork of Obion River were surveyed by W. H. Griffin, Charles Hartmann, jr., S. P. Floore, J. M. Rawls, and J. De Puy for publication on the scale of 1:31,680, with a contour interval of 5 feet. The State geologist allotted \$2,000 and the Federal Survey a like sum for the completion of primary control in the Trenton, Alamo, Greenfield, Obion, Martin, and Union City quadrangles, in Gibson, Madison, Crockett, Weakley, Obion, and Dyer counties. For this control E. L. McNair and J. M. Rawls ran 79 miles of primary levels, established 16 permanent bench marks, ran 415 miles of primary traverse, and set 46 permanent marks. In addition to the cooperative work in Tennessee, the survey of the Crossville quadrangle, in Cumberland, Bledsoe, White, and Van Buren counties, was completed and that of the Hollow Springs quadrangle, in Cannon, Coffee, Bedford, and Rutherford counties, was begun, the area mapped being 368 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by Oscar Jones, J. F. McBeth, T. F. Slaughter, J. G. Stelzenmuller, F. W. Farnsworth, and E. E. Witherspoon. For the control of the Hollow Springs and Crossville quadrangles, Messrs. Witherspoon and Farnsworth and S. E. Taylor and F. W. Crisp ran 250 miles of primary levels and established 41 permanent bench marks, and Oscar Jones ran 63 miles of primary traverse and established 4 permanent marks. Under the terms of the Weeks Act a special resurvey was made of an area covering 101 square miles in the Great Smoky Mountain National Forest, Blount and Sevier counties, for publication on the scale of 1:62,500, with a contour interval of 100 feet. This work was done by Oscar Jones, W. H. S. Morey, Charles Hartmann, jr., B. A. Kiger, S. E. Taylor, J. M. Rawls, A. F. McNair, C. W. Arnold, and C. S. Wells, the expenses being paid from the appropriation made in the act above named.

*Tennessee-North Carolina.*—J. I. Gayetty completed the revision of the Mount Guyot quadrangle, in Cooke, Lewis, and Jefferson

counties, Tenn., and Haywood, Swain, and Jackson counties, N. C., the area resurveyed being 35 square miles in Tennessee and 5 square miles in North Carolina, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

*Virginia.*—For cooperative topographic surveys in Virginia the State geologist and the United States Geological Survey each allotted \$1,750. For the control of the Gold Belt region (Palmyra, Gordonsville, and Spottsylvania quadrangles), in Louisa, Fluvanna, Goochland, Orange, Spottsylvania, and Albemarle counties, D. H. Baldwin ran 129 miles of primary traverse and set 13 permanent marks.

*Vermont.*—The survey of the Woodstock quadrangle, in Windsor County, was begun by R. D. Cummin, T. F. Slaughter, W. H. S. Morey, and Homer Dodge, the area mapped being 139 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area A. F. McNair ran 55 miles of primary levels and set 11 permanent bench marks.

*West Virginia.*—For the continuation of cooperative topographic surveys in West Virginia the State geologist allotted \$12,000 and the United States Geological Survey allotted \$10,000. The resurvey of areas previously mapped resulted in the completion of the work on the Welch, Pineville, Mullen, Holden, and Bald Knob quadrangles and the West Virginia portions of the Iaeger, Naugatuck, and Maxwell quadrangles, and of part of the work on the Logan, Louisa, and Marshes quadrangles, in McDowell, Wyoming, Logan, Raleigh, Mingo, Wayne, Boone, Lincoln, Fayette, and Welch counties, the total area mapped being 1,391 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by E. I. Ireland, Fred McLaughlin, S. E. Taylor, C. P. McKinley, C. S. Wells, A. J. Dailey, C. W. Arnold, J. H. Wilson, S. R. Truesdell, and F. E. Hale. For the control of these areas S. E. Taylor, J. B. Metcalfe, Fred McLaughlin, C. P. McKinley, and F. E. Hale ran 320 miles of primary levels and established 73 permanent bench marks. For the control of the Alton and Crawford quadrangles, in Upshur, Barbour, and Randolph Counties, D. H. Baldwin and J. I. Gayetty occupied and marked 9 triangulation stations for the control of the Red Star, Hinton, Flat Top, and Meadow Creek quadrangles, in Fayette, Summers, Mercer, Raleigh, and Wyoming counties, and C. B. Kendall and C. P. McKinley occupied 6 triangulation stations and marked 2. The survey of the West Virginia portion of the Williamsport quadrangle (the greater part of which lies in and is reported under Maryland), in Berkeley County, was also completed, the area mapped being 50 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet, in connection with which 7 miles of primary levels were run and 3 permanent bench marks were set.



## OFFICE WORK.

The drafting of the following sheets was completed: Fayette special, Ala.; Livermore and Kezar Falls, Me.; Hagerstown, Md.-Pa.; Williamsport, Md.-Pa.-W. Va.; New Berlin, Hartwick, McKeever, Hammond, and Canton, N. Y.; Hilliards, Quarryville, and McCalls Ferry, Pa.; Crossville, Mount Guyot revision, Rutherford Fork of Obion River, and North Fork of Forked Deer River, Tenn.; Mullen, Pineville, Welch, Bald Knob, Holden, W. Va., and West Virginia portions of Iaeger and Naugatuck.

Progress in the drafting of additional sheets was made as follows: Seale, Ala., 60 per cent; Buckfield, Me., 52 per cent.

In the triangulation and computing section the following work was completed:

Latitudes, departures, and geographic positions for the Stockley (Del.) and Seaford (Del.-Md.) quadrangles were computed.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Hawthorn, Interlachen, Palatka, and Starke quadrangles (Fla.). Latitudes, departures, and geographic positions for the Greencove Springs, Hague, and Welaka quadrangles (Fla.) were computed.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Greensboro, Shoulder, and Sparta quadrangles (Ga.).

Primary level circuits were adjusted and geodetic distances and positions were computed for the Buckfield and Livermore quadrangles (Me.). Geodetic distances and positions in the Bryants Pond and Sango Pond quadrangles (Me.) were computed.

Primary and precise level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Great Falls power project special survey (Md.-Va.).

Primary level circuits in the Hagerstown (Md.-Pa.) and Williamsport (Md.-W. Va.-Pa.) quadrangles were adjusted.

Primary level circuits in the Iuka quadrangle (Miss.-Tenn.-Ala.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Lowville and No. 4 quadrangles (N. Y.). Primary level circuits in the McKeever, New Berlin, and Port Leyden quadrangles (N. Y.) were adjusted. The geodetic position of the seismograph site in the American Museum of Natural History grounds in New York City was computed.

Primary level circuits in the Hilliards, McCalls Ferry, and Quarryville quadrangles (Pa.) were adjusted.

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Alamo, Crossville,

Greenfield, and Trenton quadrangles (Tenn.). Latitudes, departures, and geographic positions for the Dresden, Martin, Trenton, Trimble, and Union City (Tenn.) and Tiptonville (Tenn.-Mo.) quadrangles were computed.

Primary level notes for the Woodstock quadrangle (Vt.) were checked.

Latitudes, departures, and geographic positions for the Gordonsville, Palmyra, and Spottsylvania quadrangles (Va.) were computed.

Primary level circuits in the Holden, Mullen, and Pineville (W. Va.) and Iaeger and Welch (W. Va.-Va.) quadrangles were adjusted.

Level lists were revised and assembled, after all necessary computations and readjustments had been made, and transmitted to the editor for publication as bulletins for West Virginia (Bulletin 477) and New York.

#### CENTRAL DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Arkansas, Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Ohio. This work comprised the survey of 16 quadrangles and 1 special area and the revision of 1 special area. In addition, 20 quadrangles and 2 river projects were partly surveyed. The total new area mapped was 5,131 square miles—259 for publication on the scale of 1:125,000, 4,730 for publication on the scale of 1:62,500, and 142 for publication on the scale of 1:24,000. The area resurveyed was 57 square miles, for publication on the scale of 1:62,500. In connection with this work 2,074 miles of primary levels were run and 519 permanent bench marks were established.

Primary traverse and primary triangulation were carried on at different times by four parties, the work being distributed over portions of Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Ohio. The total area covered by this primary control was about 5,300 square miles, of which 4,840 were controlled by primary traverse, 2,088 miles being run and 218 permanent marks set. Six triangulation stations were occupied and 4 were marked. The result of this work was to make control available in 59 quadrangles.



Topographic surveys in central division from July 1, 1910, to June 30, 1911.

State.	Con- tour inter- val.	For publication on scale of—			Total area sur- veyed.	Primary levels.		Primary trav- erse.	
		1:125,000.	1:62,500.			Dis- tance run.	Bench marks.	Dis- tance. run.	Per- ma- nent marks.
		New.	New.	Resur- vey.					
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>	
Arkansas.....	20-50	245		57	302				
Oklahoma.....	50	14			14				
Illinois.....	5-20		869		a 1,011	293	47	291	37
Indiana.....	20		100		100	27	9		
Iowa.....	20		328		328	108	34	50	3
Kentucky.....	20		666		666	262	98	10	3
Michigan.....	20		193		193			466	58
Minnesota.....	10		719		719	374	101	233	28
Missouri.....	10		351		351	80	19	174	15
Ohio.....	10-20		1,504		1,504	930	211	864	74
	.....	259	4,730	57	5,188	2,074	519	2,088	218

<sup>a</sup> 142 square miles in Illinois, for publication on the scale of 1: 24,000.

DETAILS OF WORK BY STATES.

*Arkansas.*—The survey of the De Queen quadrangle, in Polk, Howard, and Sevier counties, Ark., and McCurtain County, Okla., was continued by H. H. Hodgeson and W. R. Schreiner, the area mapped being 259 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. Of this area, 14 miles lies in Oklahoma. A portion of the Hot Springs special quadrangle, in Garland and Hot Springs counties, was revised by C. L. Sadler and F. B. Barrett, the area revised being 57 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

*Illinois.*—The governor of Illinois allotted \$10,000 for the continuation of cooperative topographic surveys in Illinois, and the United States Geological Survey an equal amount for the same purpose. The governor also made an additional allotment of \$3,750 for a survey of the overflowed lands within the State, which was met by an allotment of \$1,250 by the Federal Survey. The survey of the Milan quadrangle, comprising 224 square miles in Rock Island and Mercer counties, Ill., and Scott County, Iowa, was completed. Of this area, 25 square miles lie in Iowa, and the cost of mapping that portion was paid from Federal funds. The survey of the Waterloo quadrangle, comprising 234 square miles in St. Clair and Monroe counties; of the Canton quadrangle, comprising 227 square miles in Fulton and Knox counties; and of the Illinois portion of the Kimmswick quadrangle, comprising 84 square miles in St. Clair and Monroe counties, was completed for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by Frank Tweedy, F. W. Hughes, E. L. Hain, B. A. Jenkins, O. H. Nelson, and W. S. S.

Johnson. The survey of the Colchester quadrangle, in McDonough County, was begun by Mr. Tweedy, the area mapped being 100 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Illinois portion of the Renault quadrangle, in Monroe and Randolph counties, was begun by F. W. Hughes, the area mapped being 25 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Milan quadrangle, C. B. Kendall ran 89 miles of primary traverse and set 16 permanent marks. For the control of the Renault quadrangle, C. R. French ran 20 miles of primary levels and set 5 permanent bench marks. For the control of the Waterloo quadrangle, S. R. Archer ran 67 miles of primary levels and established 17 permanent bench marks. For the control of the Kimmswick quadrangle, Mr. Archer ran 27 miles of primary levels and established 8 permanent bench marks. For the control of the Carthage, Colchester, Lomax, Keokuk, Macomb, and Vermont quadrangles, in Hancock, Schuyler, Fulton, and McDonough counties, C. B. Kendall ran 159 miles of primary traverse and set 17 permanent marks. For the control of the Marseille, Ottawa, and Earlville quadrangles, in LaSalle County, J. R. Ellis ran 43 miles of primary traverse and set 4 permanent marks. Under the allotment for surveying overflowed lands, C. C. Gardner and B. A. Jenkins continued the survey of the Spoon River project, in Fulton County, the area mapped being 11 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. For the control of this area S. R. Archer ran 11 miles of primary levels and set 3 permanent bench marks. The survey of the Embarrass River project, in Lawrence County, was continued by L. L. Lee, H. W. Peabody, and J. B. Leavitt, the area mapped being 131 square miles, for publication on the scale of 1:24,000, with a contour interval of 5 feet. For the control of this area Messrs. Peabody and Leavitt and R. G. Clinite ran 107 miles of primary levels and established 14 permanent bench marks. For the control of the Big Muddy River project, in Union, Jackson, Williamson, and Franklin counties, S. R. Archer ran 61 miles of primary levels.

*Indiana.*—The survey of the Indiana portion of the Kosmosdale quadrangle, in Floyd, Harrison, and Jefferson counties, was completed by Fred Graff, jr., the area mapped being 100 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area E. C. Bibbee ran 27 miles of primary levels and set 9 permanent bench marks.

*Iowa.*—The State geologist of Iowa allotted \$1,750 for the continuation of the cooperative topographic surveys in that State and the Federal Survey allotted an equal amount for the same purpose. The survey of the Pella quadrangle, in Marion and Mahaska coun-

ties, was completed by H. W. Peabody, the area mapped being 120 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Slater quadrangle, in Polk and Story counties, was begun by B. A. Jenkins, L. B. Roberts, and W. L. Miller, the area mapped being 156 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Slater quadrangle and of the Madrid quadrangle, in Boone, Polk, and Story counties, C. B. Kendall ran 50 miles of primary traverse and set 3 permanent marks, and C. H. Semper and Howard Clark ran 108 miles of primary levels and established 34 permanent bench marks. In addition to the cooperative work in Iowa the survey of the Iowa portion of the Galena quadrangle, in Jackson and Dubuque counties, was completed by B. A. Jenkins, the area mapped being 27 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. (See also p. 101 for the mapping of the Iowa portion of the Milan quadrangle.)

*Kentucky.*—The Kentucky Geological Survey allotted \$10,000 for the continuation of cooperative topographic surveys in Kentucky and the Federal Survey allotted an equal amount for the same purpose. The survey of the Nortonville quadrangle, comprising 238 square miles in Hopkins, Christian, and Muhlenberg counties, and of the unmapped portion of the Monticello quadrangle, comprising 108 square miles in Wayne, Pulaski, and Russell counties, was completed. This work was done by C. W. Goodlove, N. E. Ballmer, W. A. Reiter, C. L. Sadler, Fred Graff, jr., and F. B. Barrett. The survey of the Drakesboro quadrangle (formerly called Greenville), in Muhlenberg, Logan, and Todd counties, was begun by C. W. Goodlove, N. E. Ballmer, and W. A. Reiter, the area mapped being 202 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the La Grange and Taylorsville quadrangles, in Jefferson County, was begun by Fred Graff, jr., the area mapped being 88 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Crockettville quadrangle, in Perry, Breathitt, and Knott counties, was begun by J. R. Eakin, the area mapped being 30 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Nortonville quadrangle C. B. Shaw and Ed. Shea ran 83 miles of primary levels and established 29 permanent bench marks. For the control of the Monticello quadrangle F. B. Barrett ran 32 miles of primary levels and established 9 permanent bench marks. For the control of the Taylorsville quadrangle E. C. Bibbee ran 10 miles of primary levels and established 9 permanent bench marks. For the control of the Drakesboro quadrangle E. C. Bibbee ran 81 miles of primary levels

and established 25 permanent bench marks. For the control of the Crockettville quadrangle and of the Troublesome quadrangle, in Perry, Breathitt, and Knott counties, J. R. Eakin and George T. Hawkins occupied 6 triangulation stations and marked 5, and S. R. Archer ran 42 miles of primary levels and set 7 permanent bench marks. For the control of the Hickman quadrangle, in Fulton County, E. L. McNair ran 10 miles of primary traverse and set 3 permanent marks.

*Michigan.*—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted \$2,000, which was met with a like sum by the United States Geological Survey. The survey of the Lansing quadrangle, in Ingham and Eaton counties, was completed by L. L. Lee, the area mapped being 166 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Grand Rapids quadrangle, in Kent County, was begun by A. M. Walker, the area mapped being 27 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Marcellus, Schoolcraft, Gobleville, Allegan, Kalamazoo, Wayland, Jenison, Cedar Springs, Jones, Centerville, Lowell, Blissfield, Adrian, Grand Rapids, Hastings, Ionia, Vermontville, Charlotte, Muir, Reading, Hillsdale, and Hudson quadrangles, in Kalamazoo, St. Joseph, Allegan, Kent, Lowell, Lenawee, Barry, Eaton, and Hillsdale counties, J. R. Ellis and J. H. Wilson ran 296 miles of primary traverse and set 35 permanent marks. In addition to the cooperative work in Michigan, the control of the Houghton, Beacon Hill, Kenton, Winona, Watersmeet, Sidnaw, Rubicon, Perch Lake, Greenland, and Paynesville quadrangles, in Houghton, Iron, Ontonogan, Gogebic, and Baraga counties, was begun by E. L. McNair, 170 miles of primary traverse being run and 23 permanent marks being set.

*Minnesota.*—The State drainage engineer of Minnesota allotted \$8,000 for the continuation of cooperative topographic work in that State and the United States Geological Survey made an equal allotment. The survey of the uncompleted portion of the Morris quadrangle, comprising 131 square miles in Stevens County, of the Wendell quadrangle, comprising 207 square miles in Grant and Ottertail counties, and of the Chokio quadrangle, comprising 210 square miles in Stevens, Bigstone, and Traverse counties, was completed. The survey of the Ashby quadrangle, in Grant, Ottertail, and Douglas counties, was begun, the area mapped being 120 square miles; the survey of the Fergus Falls quadrangle, in Ottertail County, was begun, the area mapped being 37 square miles; and the survey of the Underwood quadrangle, in Ottertail County, was begun, the area mapped being 14 square miles. All surveys in Minnesota were made for publication on the scale of 1:62,500, with a contour interval of

10 feet. This work was done by C. L. Sadler, O. H. Nelson, W. S. S. Johnson, E. L. Hain, and F. B. Barrett. For the control of the Wendell quadrangle J. M. Ray ran 17 miles of primary levels and established 2 permanent bench marks. For the control of the Chokio quadrangle E. C. Bibbee ran 45 miles of primary levels and established 13 permanent bench marks. For the control of the Ashby quadrangle J. M. Ray ran 78 miles of primary levels and established 19 permanent bench marks. For the control of the Fergus Falls, Underwood, and Battle Lake quadrangles, in Ottertail County, J. M. Ray and E. C. Bibbee ran 234 miles of primary levels and established 67 permanent bench marks, and C. B. Kendall ran 233 miles of primary traverse and set 28 permanent marks.

*Missouri.*—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted \$4,000 and the United States Geological Survey allotted an equal amount. The survey of the Aurora special area, embracing 331 square miles, in Barry, Jasper, Lawrence, and Newton counties, was completed by H. H. Hodgeson, W. H. Phelps, and W. R. Schreiner, for publication on the scale of 1:62,500, with a contour interval of 10 feet. The survey of the Queen City quadrangle, in Putnam, Adair, and Schuyler counties, was begun by W. J. Lloyd and P. W. McMillen, the area mapped being 20 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Queen City quadrangle and of the Green City quadrangle, in the same counties, P. W. McMillen ran 80 miles of primary levels and established 19 permanent bench marks, and C. B. Kendall ran 174 miles of primary traverse and set 15 permanent marks.

*Ohio.*—The governor of Ohio allotted \$25,000 and the United States Geological Survey allotted \$15,000 for the continuation of cooperative topographic surveys in Ohio. The survey of the unmapped portion of the Carrollton quadrangle, covering 164 square miles in Carroll, Stark, and Columbiana counties, and of the Laurelville quadrangle, covering 150 square miles in Pickaway, Ross, Vinton, and Hocking counties, was completed. The survey of the Oak Hill quadrangle, comprising 232 square miles in Jackson, Gallia, Lawrence, and Scioto counties, and of the Scioto quadrangle, comprising 232 square miles in Scioto, Jackson, and Pike counties, was completed. The survey of the Jackson quadrangle, in Jackson, Vinton, and Ross counties, was begun, the area mapped being 145 square miles; that of the Navarre quadrangle, in Tuscarawas, Stark, Holmes, and Wayne counties, was begun, the area mapped being 49 square miles; that of the Sidney quadrangle, in Shelby, Logan, and Champaign counties, was begun, the area mapped being 60 square miles; that of the New Comerstown quadrangle, in Tuscarawas, Coshocton, and Holmes counties, was begun, the area mapped being



74 square miles; that of the Celina quadrangle, in Mercer and Van Wert counties, was begun, the area mapped being 176 square miles; that of the Circleville and Era quadrangles, in Pickaway, Fairfield, Ross, and Fayette counties, was begun, the area mapped being 170 square miles; and that of the Van Wert quadrangle, in Van Wert and Paulding counties, was begun, the area mapped being 52 square miles. The total area mapped in Ohio was 1,504 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. This work was done by J. H. Jennings, M. Hackett, L. D. Townsend, W. S. S. Johnson, J. A. Duck, E. L. Hain, W. N. Vance, Fred Graff, jr., O. H. Nelson, A. P. Meade, W. H. Griffin, W. H. Rayner, and F. W. Hughes. For the control of the Oak Hill quadrangle C. E. Mills ran 31 miles of primary levels and established 8 permanent bench marks. For the control of the Scioto quadrangle Mr. Mills ran 19 miles of primary levels and established 6 permanent bench marks. For the control of the Van Wert and Paulding quadrangles Mr. Mills, A. D. Duck, and Howard Clark ran 107 miles of primary levels and set 31 permanent bench marks. For the control of the Celina quadrangle Mr. Clark ran 73 miles of primary levels and established 18 permanent bench marks. For the control of the Circleville and Era quadrangles James Rayburn and A. D. Duck ran 93 miles of primary levels and established 23 permanent bench marks. For the control of the Navarre quadrangle E. C. Bibbee and C. W. Howell ran 25 miles of primary levels and established 6 permanent bench marks. For the control of the Otway quadrangle, in Scioto and Pike counties, C. B. Shaw, C. E. Mills, and Howard Clark ran 119 miles of primary levels and established 26 permanent bench marks; for the control of the Vanceburg quadrangle, in Adams and Lewis counties, 34 miles of primary levels and 4 permanent bench marks; for the control of the Portsmouth quadrangle, in Scioto County, 13 miles of primary levels and 2 permanent bench marks; for the control of the Peebles quadrangle, in Adams County, 120 miles of primary levels and 24 permanent bench marks; for the control of the Marysville and Manchester quadrangles, in Brown and Adams counties, 19 miles of primary levels and 5 permanent bench marks; for the control of the Berne quadrangle, in Mercer and Van Wert counties, 22 miles of primary levels and 6 permanent bench marks; for the control of the West Union quadrangle, in Brown and Adams counties, 90 miles of primary levels and 14 permanent bench marks; for the control of the Bobo quadrangle, in Van Wert County, 20 miles of primary levels and 6 permanent bench marks. For the control of the Brinkhaven and Plimpton quadrangles, in Coshocton, Holmes, Knox, Wayne, and Ashland counties, E. C. Bibbee ran 47 miles of primary levels and established 10 permanent bench marks; for the control of the Millers-

burg quadrangle, in Holmes and Wayne counties, Mr. Bibbee ran 46 miles of primary levels and established 11 permanent bench marks, and for the control of the Sidney quadrangle 52 miles of primary levels and 11 permanent bench marks. For the control of the Bethel, Georgetown, Maysville, West Union, Lawrenceburg, Harrison, Bucyrus, Fort Recovery, Lexington, Liberty, Norwalk, Paulding, Plymouth, Richmond, Siam, Union City, Brinkhaven, Cardington, Fredericktown, Marysville, Mount Gilead, Mount Vernon, Perrysville, Plimpton, Urbana, Larue, Mechanicsburg, Kenton, East Liberty, Bellefontaine, Halls Corners, and Alger quadrangles, in Clermont, Brown, Adams, Hamilton, Butler, Crawford, Darke, Mercer, Morrow, Knox, Richland, Preble, Huron, Paulding, Seneca, Coshocton, Morris, Delaware, Marion, Union, Madison, Champaign, Hardin, and Clark counties, J. R. Ellis ran 864 miles of primary traverse and established 74 permanent marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Hot Springs, Ark., revision; Waterloo, Canton, Milan, and Galena, Ill.; Pella, Iowa; Kosmosdale, Ind.-Ky.; Nortonville and Prospect, Ky.; Lansing, Mich.; Chokio, Morris, and Wendell, Minn.; Aurora special, Mo.; Laurelville, Carrollton, Oak Hill, and Canal Dover, Ohio.

Progress in the drafting of additional sheets was made as follows: De Queen, Ark., 40 per cent; La Grange, Ky., 8 per cent; Taylorsville, Ky., 33 per cent; Jackson, Ohio, 41 per cent; Scioto, Ohio, 18 per cent; Kimmswick, Ill., 32 per cent; Embarrass River project, Ill., 47 per cent; Spoon River project, Ill., 80 per cent; Ashby, Minn., 12 per cent.

In the triangulation and computing section the following work was completed:

Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Carthage, Colchester, La Harpe, and Lomax quadrangles (Ill.). Primary level circuits in the Birds, Hardinville, Newton, and Waterloo (Ill.), Kimmswick (Ill.-Mo.), and Vincennes (Ill.-Ind.) quadrangles were adjusted and latitudes, departures, and geographic positions for the Augusta, Avon, Canton, Galesburg, Glasford, Good Hope, Havana, Macomb, Manilo, Maquon, and Vermont (Ill.), Milan, and Madison (Ill.-Iowa), and Keokuk (Ill.-Mo.-Iowa) quadrangles were computed. Primary level notes were checked and latitudes, departures, and geographic positions were computed for the Madrid and Slater quadrangles (Iowa). Primary level circuits in the Dawson Springs, Nortonville, and Taylorsville quadrangles (Ky.) were adjusted;



latitudes, departures, and geographic positions for the Water Valley (Ky.) and Hickman (Ky.-Tenn.-Mo.) quadrangles were computed; and geodetic distances and positions for the Crockettville and Troublesome quadrangles (Ky.) were computed. Latitudes, departures, and geographic positions for the Gobleville, Marcellus, and Schoolcraft (Mich.) and Centerville and Jones (Mich.-Ill.) quadrangles were computed. Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Ashby and Wendell quadrangles (Minn.). Primary level circuits in the Chokio quadrangle (Minn.) were adjusted and latitudes, departures, and geographic positions for the Axel, Battle Lake, Dora, Fergus Falls, Henning, New York Mills, Pelican Rapids, Perham, Rothsay, and Underwood quadrangles (Minn.) were computed. Latitudes, departures, and geographic positions for the Boynton, Edina, Green City, Kirksville, Queen City, and Winigan (Mo.) and Centerville and Moulton (Mo.-Iowa) quadrangles were computed. Primary level circuits were adjusted and latitudes, departures, and geographic positions were computed for the Brinkhaven, Otway, Peebles, Plimpton, and West Union (Ohio) and Georgetown, Maysville, Portsmouth, Rectorville, and Vanceburg (Ohio-Ky.) quadrangles. Primary level circuits in the Bainbridge, Canal Dover, Hillsboro, Jackson, Laurelville, Millersburg, Navarre, New Comerstown, Scioto, and Wooster (Ohio) and Greenup (Ohio-Ky.) quadrangles were adjusted and latitudes, departures, and geographic positions for the Batavia, Bucyrus, Cardington, Celina, Defiance, Fredericktown, Hamilton, Mark Center, Mason, Mount Gilead, Mount Vernon, Paulding, Perrysville, Shauck, and Van Wert (Ohio), Bobo, Halls Corners, Harrison, Liberty, Lynn, Portland, Richmond (Ohio-Ind.), Bethel (Ohio-Ky.), and Lawrenceburg (Ohio-Ind.-Ky.) quadrangles were computed.

Level lists were revised and assembled after all necessary computations and readjustments had been made and transmitted to the editor for publication as bulletins for the following States or groups of States: Illinois (Bulletin 493), Iowa (Bulletin 460), Minnesota (Bulletin 453), Missouri (Bulletin 459), Ohio (Bulletin 476), Michigan and Wisconsin (Bulletin 461), and Arkansas, Louisiana, and Mississippi (Bulletin 458).

#### ROCKY MOUNTAIN DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Colorado, Montana, New Mexico, Oklahoma, South Dakota, and Wyoming. This work comprised the survey of 5 quadrangles and

3 special areas, and the revision of 5 quadrangles and 1 national park. In addition, 9 quadrangles, 1 special area, and 1 national park were partly surveyed and 1 quadrangle was partly revised. The total new area mapped was 4,661 square miles—1,095 for publication on the scale of 1:250,000, 2,865 for publication on the scale of 1:125,000, 377 for publication on the scale of 1:62,500, 180 for publication on the scale of 1:31,680, 134 for publication on the scale of 1:24,000, and 10 for publication on the scale of 1:12,000. The area resurveyed was 3,335 square miles—229 for publication on the scale of 1:62,500 and 3,106 for publication on the scale of 1:125,000. In connection with this work 607 miles of primary levels were run and 156 permanent bench marks were established. A profile survey of 1 river was also made, the distance traversed being 213 miles.

Primary triangulation was carried on at different times by two parties, the work being distributed over portions of Colorado and Wyoming. The total area covered by this primary control was about 6,300 square miles, and 24 triangulation stations were occupied and 27 marked. The result of this work was to make control available in 8 quadrangles and 1 national park.

Topographic surveys in Rocky Mountain division, July 1, 1910, to June 30, 1911.

State.	Contour interval.	For publication on scale of—						Total area mapped.	Primary levels.	
		1:250,000.	1:125,000.		1:62,500.		1:31,680.		Dis- tance run.	Bench marks.
		New.	New.	Resur- vey.	New.	Resur- vey.	New.			
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>	
Colorado.....	25, 50, 100	.....	715	170	.....	229	144	<sup>a</sup> 1, 392	303	92
Montana.....	5, 20, 100	.....	837	.....	167	.....	36	1, 040	97	30
New Mexico...	25, 100, 200	1, 095	522	30	45	.....	.....	<sup>b</sup> 1, 702	77	12
Oklahoma.....	50	.....	.....	2, 906	.....	.....	.....	2, 906	.....	.....
South Dakota..	50	.....	638	.....	.....	.....	.....	638	60	14
Wyoming.....	25, 50	.....	153	.....	165	.....	.....	318	70	8
	.....	1, 095	2, 865	3, 106	377	229	180	7, 996	607	156

<sup>a</sup> 134 square miles in Colorado for publication on scale of 1:24,000.  
<sup>b</sup> 10 square miles in New Mexico for publication on scale of 1:12,000.

DETAILS OF WORK BY STATES.

*Colorado.*—The survey of the Creede special area, covering the Creede mining district, in Mineral County, was completed by R. H. Reineck, the total area mapped being 26 square miles, for publication on the scale of 1:24,000, with a contour interval of 50 feet. The survey of the De Beque oil field, in Mesa and Garfield counties, was completed by A. P. Meade, jr., the area mapped being 140 square miles, for publication on the scale of 1:31,680, with a contour interval of 25 feet. The survey of the Mesa Verde National Park, in

La Plata and Montezuma counties, was begun by R. W. Berry, the area mapped being 108 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. The survey of the Hahns Peak quadrangle, in the Park Range National Park, Routt and Jackson counties, and of the Price quadrangle, in the San Juan National Forest, Archuleta County, was begun by Gilbert Young, J. F. McBeth, Lee Morrison, P. W. McMillen, and S. T. Penick, the total area mapped being 715 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The revision of the Central City quadrangle, in Gilpin, Grand, and Clear Creek counties, was completed by Lee Morrison, the area revised being 229 square miles, for publication on the scale of 1:62,500, with a contour interval of 100 feet. The revision of the Castle Rock quadrangle, in Douglas, Elbert, and El Paso counties, was commenced by C. G. Anderson, the area mapped being 170 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

For the control of these areas and of the Meeker, Piceance, Pagoda, Lily, Elkhead, Hahns Peak, Lay, and Pinon Valley quadrangles, in Garfield, Rio Blanco, Routt, and Mesa counties, C. H. Semper, P. W. McMillen, M. R. McDanal, and F. H. Nelson ran 303 miles of primary levels, and established 92 permanent bench marks, and C. F. Urquhart occupied 17 triangulation stations and marked 18.

*Montana.*—The survey of the Cherry Ridge quadrangle (formerly called Avery), in Chouteau County, was completed by Basil Duke, C. A. Leonard, and C. Ecklund, the area mapped being 395 square miles, for publication on the scale of 1:125,000, with a 20-foot contour interval. The survey of the Poplar, Chelsea, and Brockton quadrangles, in Valley and Dawson counties, was commenced by W. L. Miller and J. H. Wilke, the total area mapped being 167 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Melrose special area, in Silver Bow and Beaverhead counties, was begun by R. H. Reineck, the area mapped being 36 square miles, for publication on the scale of 1:31,680, with a contour interval of 50 feet. The survey of the Nyack and Midvale quadrangles, lying partly in the Glacier National Park and the Black-foot, Flathead, and Lewis and Clark national forests, Teton and Flathead counties, was begun by R. T. Evans, S. T. Penick, C. A. Ecklund, W. J. Foster, and F. L. Whaley, the area mapped being 442 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. A survey of Clark Fork, in Powell, Granite, and Missoula counties, was begun by R. C. Seitz, the distance traversed being 213 miles. For the control of the Cherry Ridge quadrangle C. A. Leonard ran 44 miles of primary levels and established 17 permanent bench marks. For the control of the Poplar, Chelsea, and Brockton quadrangles J. H. Wilke ran 53 miles of

primary levels and established 13 permanent bench marks. (See also p. 112.)

*New Mexico.*—The survey of the Kelly special area, in Socorro County, was completed by R. H. Reineck, the area mapped being 10 square miles, for publication on the scale of 1:12,000, with a contour interval of 25 feet. The survey of the Cloudcroft 1-degree quadrangle, in the Alamo National Forest, Otero and Chaves counties, was completed by J. H. Wilke and C. A. Ecklund, the area mapped being 1,095 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the Camp Vincent quadrangle, in the Datil National Forest, Grant and Socorro counties, was begun by A. B. Searle and S. T. Penick, the area mapped being 522 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. A small area within the Silver City quadrangle, comprising 30 square miles, was revised by A. B. Searle, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Raton quadrangle, in Colfax County, was commenced by E. P. Davis, the area mapped being 45 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this quadrangle a primary level line was started at Thatcher, Colo., by C. P. Gross, who ran 77 miles of primary levels and established 12 permanent bench marks. For the control of the Camp Vincent and Fairview quadrangles R. B. Robertson occupied 1 triangulation station and marked 7.

*Oklahoma.*—The revision of culture in the Antlers, Nowata, and Claremore quadrangles, in Atoka, Bryan, Choctaw, Pushmataha, Nowata, Washington, Rogers, and Tulsa counties, was completed by Lee Morrison, C. C. Gardner, A. O. Burkland, F. B. Barrett, and C. J. Ballinger, the total area revised being 2,906 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

*South Dakota.*—The survey of the unmapped portion of the Newell quadrangle (formerly called Empire, the southwest quarter of which is the Vale 15-minute quadrangle, surveyed in 1904) was completed by G. S. Smith and C. P. Gross, the area mapped being 638 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this area H. L. Caldwell ran 60 miles of primary levels and established 14 permanent bench marks.

*Wyoming.*—The survey of the Wiley quadrangle, in Bighorn County, was begun by C. C. Gardner, the area mapped being 165 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Cheyenne quadrangle, in Laramie County, was begun by E. P. Davis and continued by Basil Duke and H. L. Caldwell, the area mapped being 153 square miles, for publication on the scale of 1:125,000, with a contour interval of

50 feet. For the control of the Wiley quadrangle C. W. Rowell ran 70 miles of primary levels, and established 8 permanent bench marks. For the control of the Cheyenne quadrangle G. T. Hawkins occupied 6 triangulation stations and marked 2.

In addition to the work mentioned above, culture was revised and brought up to date in the Gallatin, Canyon, Shoshone, and Lake quadrangles, comprising the Yellowstone National Park, Wyoming, Montana, and Idaho, under a special allotment by the Department of the Interior for the preparation of an administrative map of the Yellowstone National Park.

#### OFFICE WORK.

The drafting of the following sheets was completed: De Beque oil field, Creede special, and Central City, Colo.; Chelsea, Cherry Ridge, Hay Creek, Smoke Creek, and Poplar, Mont.; Nowata, Okla.; Newell, S. Dak.; Kelly special and Mogollon, N. Mex.; Millican and Washington, Tex.

Progress in the drafting of additional sheets was made as follows: Price, Colo., 18 per cent; Hahns Peak, Colo., 45 per cent; Mesa Verde, Colo., 85 per cent; Midvale, Mont., 19 per cent; Nyack, Mont., 25 per cent; Camp Vincent, N. Mex., 40 per cent; and Wiley, Wyo., 50 per cent.

In the triangulation and computing section the following work was completed:

Primary level circuits were adjusted and geodetic distances and positions were computed for the Cortez, De Beque special, Elkhead, Hahns Peak, Hesperus, Meeker, Pagoda, and Rifle quadrangles (Colo.). Primary level circuits in the Durango, Grand Junction, Ignacio, La Plata, Lewis Creek, and Rabbits Ears Peak quadrangles (Colo.) were adjusted, and geodetic distances and positions for the Cameo, Hotchkiss, Lay, Lily, Montrose, Piceance, and Pinon Valley quadrangles (Colo.) were computed.

Primary level circuits in the Brockton, Cherry Ridge, Harlem, Poplar, Red Lodge, and Wolf Point quadrangles (Mont.) were adjusted. The single spur line running through the Willis quadrangle (Mont.) and the Polaris quadrangle (Mont.-Idaho) was checked. Primary level circuits run by the General Land Office in the Milk River, No. 2, Whiskey Butte, and Wolf Point quadrangles (Mont.) were adjusted.

Partial computations of geodetic distances and positions in the Mescalero and Tularosa quadrangles (N. Mex.) were made.

Primary level circuits run by the General Land Office in the Blue Butte, Elbowoods, and Ryder quadrangles (N. Dak.) were adjusted.

Primary level circuits in the Empire quadrangle (S. Dak.) were adjusted.

Primary level circuits in the Baggs, Rawlins, Savery Creek, and Wiley quadrangles (Wyo.) were adjusted and geodetic distances and positions for the Cheyenne quadrangle (Wyo.) were computed.

Level lists were revised and assembled, after all necessary computations and readjustments had been made, and transmitted to the editor for publication as bulletins for the following States or groups of States; Colorado (Bulletin 486), Montana (Bulletin 482), New Mexico (Bulletin 464), North Dakota (Bulletin 469), South Dakota (Bulletin 472), Texas (Bulletin 468), and Kansas and Nebraska (Bulletin 473).

#### PACIFIC DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Idaho, Nevada, Oregon, Utah, and Washington. This work comprised the survey of 12 quadrangles, the partial survey of 30 quadrangles, 1 special area, and 1 national park, the resurvey or revision of 8 quadrangles, 3 special areas, and 1 national monument, and the partial resurvey of 8 quadrangles. The total new area mapped was 10,154 square miles—3,610 for publication on the scale of 1:250,000, 5,447 for publication on the scale of 1:125,000, 952 for publication on the scale of 1:62,500, and 145 for publication on the scale of 1:31,680. The area resurveyed was 1,315 square miles, 600 for publication on the scale of 1:125,000, 268 for publication on the scale of 1:62,500, 430 for publication on the scale of 1:31,680, and 17 for publication on the scale of 1:12,000. In connection with this work 1,776 miles of primary levels were run and 358 permanent bench marks were established. In addition, profile surveys of 11 rivers were made, the distance traversed being 541 miles. Topographic surveys were also carried on in the Territory of Hawaii, the area mapped being one island, embracing portions of four 15-minute quadrangles, and the partial survey of one island, covering portions of three quadrangles, the area mapped being 224 square miles, for publication on the scale of 1:31,680, in connection with which 178 miles of primary levels were run and 60 permanent bench marks set.

Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of California, Idaho, Oregon, Utah, and Washington. The total area covered by this primary control was about 6,300 square miles, of which 3,000 were controlled by primary traverse, 486 miles being run and 61 permanent marks set; 38 triangulation stations were occupied and 44 were marked. The result of this work was to make control available in 24 quadrangles.



*Topographic surveys in Pacific division from July 1, 1910, to June 30, 1911.*

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\* 600 square miles resurveyed in Arizona for publication on scale of 1:125,000, and 17 square miles for publication on scale of 1:12,000.

#### DETAILS OF WORK BY STATES.

*Arizona.*—The survey of the Winkleman quadrangle, in Pinal and Gila counties, Ariz., was completed by J. E. Blackburn, Pearson Chapman, J. G. Staack, S. T. Penick, and T. P. Pendleton, the total area mapped being 958 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The resurvey of the Miami and Ray special areas, in Gila and Pinal counties, was completed by W. M. Beaman, for publication on the scale of 1:12,000, with a contour interval of 25 feet, the total area mapped being 17 square miles. The resurvey of the Petrified Forest National Monument, in Navajo and Apache counties, was completed by Pearson Chapman and J. G. Staack, the total area mapped being 268 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of this area 40 miles of primary levels were run and 10 permanent bench marks established. The revision of a portion of the Flagstaff quadrangle, in the Coconino and Tusayan national forests, in Coconino County, was completed by W. M. Beaman, the total area revised being 600 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

*California.*—The department of engineering of California allotted \$14,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum for the same purpose. In the Sacramento Valley the resurvey of the Marysville quadrangle and of the Sacramento Valley portions of the Smartsville and Chico quadrangles, in Yuba, Sutter, Colusa,



Butte, Glenn, and Tehama counties, was completed, and resulted in the completion of the Nelson, Marysville Buttes, Pennington, Nord, Dayton, Durham, Newhard, and Dry Creek 7½-minute quadrangles, and of the valley portions of the Spenceville, Oroville, Singer Creek, Keefers, Clear Creek, and Bangor 7½-minute quadrangles, the total are resurveyed being 430 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet.

In the Salinas Valley the mapping of the Gonzales and Soledad quadrangles, in Monterey and San Benito counties, was started, the total area mapped being 99 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The mapping of the Stockton and Brentwood 7½-minute quadrangles, in the San Joaquin Valley, in San Joaquin and Contra Costa counties, was commenced, the area mapped being 57 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The work in the Sacramento, Salinas, and San Joaquin valleys was done by Duncan Hannegan, W. H. Griffin, T. H. Moncure, J. W. Muller, M. A. Knock, Bayard Knock, J. L. Lewis, J. P. Harrison, A. T. Fowler, A. J. Ogle, W. R. Chenoweth, R. M. La Follette, and A. E. Bungay. For the control of the Byron, Stockton, and Tracy 15-minute quadrangles, in the San Joaquin Valley, in San Joaquin, Contra Costa, and Alameda counties, L. F. Biggs and G. L. Hagman ran 269 miles of primary levels and established 62 permanent bench marks, and occupied 10 and marked 9 triangulation stations.

In addition to the cooperative work in California, the survey of the Bakersfield quadrangle, in Kern County, was completed by J. L. Lewis and Bayard Knock, the total area mapped being 567 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Mariposa quadrangle, in Mariposa, Fresno, and Madera counties, was completed by E. R. Bartlett, T. P. Pendleton, and J. W. Muller, the total area mapped being 345 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Coalinga and Panoche quadrangles, in Kings, Monterey, Fresno, San Benito, and Merced counties, was completed by H. L. McDonald and J. L. Lewis, the total area mapped being 879 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Petaluma quadrangle, in Sonoma and Marin counties, was commenced by J. G. Staack and M. A. Knock, the total area mapped being 170 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. A small area, covering about half a square mile in the Randsburg quadrangle, in San Bernardino and Kern counties, was revised by T. P. Pendleton. The survey of the Weaverville, Big Bar, and Korbel quadrangles, in the Trinity National Forest, in Trinity and Humboldt counties, was continued by

J. P. Harrison and Oscar Jones, the total area mapped being 259 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet, and 54 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Bishop quadrangle, in the Inyo National Forest, in Inyo County, was continued by G. R. Davis and B. A. Jenkins, the total area mapped being 720 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Caliente quadrangle, in the Sequoia National Forest, was continued by C. F. Eberly, R. M. La Follette, and J. W. Muller, the total area mapped being 613 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the additional control of the Caliente quadrangle 145 miles of primary levels were run and 28 permanent bench marks were set by K. W. Trimble and G. L. Hagman.

*California-Nevada.*—The survey of the western half of the Ballarat 1-degree quadrangle, in Inyo County, Cal., and of the southwest quarter of the Lida 1-degree quadrangle, in Inyo County, Cal., and Esmeralda County, Nev., was completed by J. E. Blackburn and T. P. Pendleton, the total area mapped being 2,860 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. Of this area, 200 square miles are in Nevada.

*Idaho.*—The survey of the Panhandle 1-degree quadrangle in the Pend Oreille National Forest, in Kootenai, Shoshone, Saunders, and Lincoln counties, was continued by J. W. Muller and T. P. Pendleton, the total area mapped being 491 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. The survey of the Wayan quadrangle, which lies partly in the Caribou National Forest, in Bannock and Bear Lake counties, was continued by Albert Pike and W. O. Tufts, the total area mapped being 220 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Wayan quadrangle 73 miles of primary levels were run and 20 permanent bench marks were established by Mr. Tufts, D. S. Birkett, and O. G. Taylor, and 6 triangulation stations were occupied and 4 marked by G. T. Hawkins. For the control of the Lolo quadrangle L. F. Biggs ran 75 miles of primary levels and set 18 permanent bench marks.

*Idaho-Montana.*—The survey of the St. Regis and Taft quadrangles, in the Cœur d'Alene National Forest, in Shoshone County, Idaho, and Missoula and Sanders counties, Mont., was commenced by J. E. Blackburn, the total area mapped being 135 square miles, of which 35 are in Montana, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Salmon quadrangle, lying partly in the Shoshone National Forest, and the Dillon quadrangle, in Lemhi County, Idaho, and Beaverhead

County, Mont., W. H. Barringer ran 89 miles of primary levels and established 19 permanent bench marks. A profile survey of Salmon River, in the Salmon, Idaho, and Nez Perce national forests, was also commenced by Mr. Barringer and continued by O. G. Taylor, the total number of miles traversed being 107.

*Oregon.*—The State engineer of Oregon allotted \$2,500 for the continuation of the cooperative topographic surveys in that State, which was met by a like sum for the same purpose from the United States Geological Survey. The survey of the Willamette Valley was continued and resulted in the completion of the Halsey 15-minute quadrangle (Shedds and Peoria 7½-minute) in Linn and Benton counties, the total area mapped being 108 square miles, for publication on the scale of 1:62,500, with a contour interval of 7 feet; and of parts of the Monroe, Albany, and Brownsville quadrangles, in Linn and Benton counties, the area mapped being 21 square miles, for publication on the scale of 1:62,500, with a contour interval of 5 feet. This work was done by H. L. McDonald, E. R. Bartlett, A. J. Ogle, J. M. Rawls, and A. F. McNair. For the control of these areas A. Finlay, J. M. Rawls, and A. G. Humphreys ran 101 miles of primary levels and established 28 permanent bench marks. The survey of the Boring and Oregon City quadrangles, in Multnomah and Clackamas counties, was begun by J. H. Wheat, the area mapped being 18 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas C. F. Urquhart ran 82 miles of primary traverse and set 16 permanent marks, and E. M. Bandli ran 33 miles of primary levels and established 10 permanent bench marks. The survey of the Pine quadrangle, in the Wallowa National Forest, in Baker and Union counties, was commenced by S. G. Lunde and G. S. Smith, the area mapped being 49 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. In addition to the cooperative work, the survey of the Cazadero quadrangle, in the Oregon National Forest, in Clackamas and Multnomah counties, was commenced by A. E. Murlin, the area mapped being 49 square miles, for publication on a scale of 1:125,000, with a contour interval of 100 feet. For the control of this area E. M. Bandli ran 124 miles of primary levels and established 35 permanent bench marks, and O. C. Kintner ran 137 miles of primary traverse and set 23 permanent marks.

*Oregon-Washington.*—The survey of the Mount Hood special quadrangle, which lies partly in the Bull Run National Forest, in Multnomah, Clackamas, and Wasco counties, Oreg., and Clarke and Skamania counties, Wash., was continued by R. M. La Follette and T. P. Pendleton, the area mapped being 251 square miles, for publi-

cation on the scale of 1:125,000, with a contour interval of 100 feet. Of the area mapped, 105 square miles lies in Washington.

*Utah.*—The survey of the Sunnyside quadrangle, in Carbon County, was commenced by T. M. Bannon and S. P. Floore, the area mapped being 65 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this quadrangle and of the Salt Lake, Fort Douglas, Provo, Millfork, Soldiers Summit, Kyune, Castlegate, Wellington, Mounds, Grassy, and Beckworth Peak quadrangles, in Utah and Salt Lake counties, L. F. Biggs ran 535 miles of double primary levels and established 60 permanent bench marks. For the control of the Kyune, Wellington, Soldiers Summit, Westwater, Mount Wass, Moab, Ninemile Creek, Sunnyside, and Tidwell quadrangles, in Carbon, Emery, Grand, Utah, and Wasatch counties, T. M. Bannon occupied 22 triangulation stations and marked 31.

*Utah-Wyoming.*—The survey of the Randolph quadrangle, which lies partly in the Cache National Forest, in Rich and Cache counties, Utah, and Uinta County, Wyo., was completed by A. E. Murlin, the total area mapped being 442 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of the area mapped, 27 square miles lie in Wyoming.

*Washington.*—Under the allotment of \$12,500 each, made by the Board of Geological Survey of Washington, and the United States Geological Survey, topographic mapping was continued and resulted in the completion of the mapping of the Beverly and Moses Lake quadrangles, in Grant County, and of part of the Cedar Lake quadrangle, in King and Pierce counties, the total area mapped being 526 square miles—276 for publication on the scale of 1:62,500, and 385 for publication on the scale of 1:125,000. This work was done by W. O. Tufts, Robert Muldrow, C. F. Eberly, O. G. Taylor, and L. R. Ebert. The survey of the Palisades quadrangle, in Grant County, and of the Grays Harbor quadrangle, in Pacific County, was begun by H. L. McDonald and Charles Hartmann, the total area mapped being 38 square miles, for publication on the scale of 1:62,500, with a 25-foot contour interval. For the control of the Moses Lake and Cedar Lake quadrangles, D. S. Birkett ran 191 miles of primary levels and established 42 permanent bench marks; G. T. Hawkins and O. C. Kintner ran 267 miles of primary traverse and set 22 permanent marks. For the control of the Grays Harbor quadrangle, G. L. Hagman ran 56 miles of primary levels and set 14 permanent bench marks. Profile surveys were also made by Bayard Knock, W. B. Lewis, and T. H. Moncure of portions of Cowlitz, Cispus, Nisqually, Carbon, Puyallup, White, American, Bumping, Naches, and Tieton rivers, the total distance traversed being 434 miles. In addition to the cooperative work in Washing-

ton, a survey of the Mount Rainier National Park, in Pierce County, was started by F. E. Matthes and G. R. Davis, the total area mapped being 36 square miles, for publication on the scale of 1:62,500, with a contour interval of 100 feet. For the control of this area E. M. Bandli ran 45 miles of primary levels and established 12 permanent bench marks.

*Hawaii.*—In 1909 a cooperative agreement was entered into between the superintendent of public works of the Territory of Hawaii and the United States Geological Survey whereby the Survey loaned instruments and detailed topographers to the Territory to begin the topographic survey of the island of Kauai, the entire expense of the work, including transportation of instruments and salaries and expenses of the topographers, being borne by the Territorial government. Under this arrangement a portion of the island of Kauai embracing 374 square miles was surveyed prior to June 30, 1910. This work was done by G. R. Davis, H. L. McDonald, A. J. Ogle, O. G. Taylor, A. T. Fowler, J. L. Lewis, T. H. Moncure, W. H. Barringer, and C. H. Birdseye, under the immediate charge of Mr. Birdseye, topographer. For the control of this area L. F. Biggs ran 184 miles of primary levels and established 44 permanent bench marks.

On July 1, 1910, an agreement was entered into for the fiscal year beginning July 1, 1910, and ending June 30, 1911, whereby the Territory allotted \$15,000 and the United States Geological Survey \$5,000 for the continuation of the cooperative survey of the island of Kauai, begun in 1909. Since that date the mapping of the island of Kauai has been completed, the area mapped being 173 square miles, making a total area surveyed of 547 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet, in one sheet as the island of Kauai. A map of a portion of this area, embracing about 100 square miles of irrigable land, will be published separately on the scale of 1:31,680, with a contour interval of 10 feet. After the completion of the mapping of the island of Kauai a survey was begun of the northern portion of the island of Hawaii, the area mapped to June 30, 1911, being 51 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The work during this fiscal year was done by C. H. Birdseye, A. T. Fowler, and W. H. Barringer, under the immediate direction of Mr. Birdseye. For the control of these areas W. H. Barringer ran 178 miles of primary levels and established 60 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Biggs, Gridley, Dayton, Durham, Newhard, Mount Goddard, Eddys, Salinas, Marysville Buttes, Bangor, Pennington, Dry Creek, Oroville,



Honecut, Palermo, Mariposa, French Crossing, Keefers, Clear Creek, Randsburg (revision), Butte Creek, Nord, Nelson, and Tisdale Weir, Cal.; Ivanpah, Cal.-Nev.; Miami special, Ray special, and Petrified Forest, Ariz.; Salmon River profile, Idaho; Randolph, Utah; Moses Lake and Beverly, Wash.; Shedd and Peoria, Oreg.; Mana, Na Pali, Hanapepe, Kilauea, Kapaa, Lihue, Hanalei, and Waimea, Hawaii.

Progress in the drafting of additional sheets was made as follows: Soledad, Cal., 19 per cent; Big Bar, Cal., 80 per cent; Bishop, Cal., 15 per cent; Gonzales, Cal., 45 per cent; Singer Creek, Cal., 70 per cent; Ballarat, Cal.-Nev., 50 per cent; Panhandle, Idaho, 30 per cent; Wayan, Idaho, 20 per cent; Mount Hood, Oreg., 85 per cent; Cedar Lake, Wash., 25 per cent; Mount Rainier National Park, Wash., 11 per cent.

In the triangulation and computing section the following work was completed:

Primary level circuits in the Petrified Forest quadrangle (Ariz.) were adjusted.

Primary level circuits were adjusted and preliminary geodetic distances and positions were computed for the Byron, Holt, Lathrop, Stockton, Tracy, and Union Island quadrangles (Cal.). Primary level circuits in the Bakersfield, Caliente, McKittrick, Mojave, and Tejon quadrangles (Cal.) were adjusted, and preliminary geodetic distances and positions for the Avena, Clyde, Copperopolis, Monteca, Oakdale, Peters, and Trigo quadrangles (Cal.) were computed. A double primary line of levels run by the water resources branch in the Hanford quadrangle (Cal.) was adjusted.

Primary level circuits run with a prism level in the Kapaa, Lihue, Na Pali, and Waimea quadrangles, in Kauai Island, Hawaii, were adjusted.

A spur line of primary levels through the Junction, May, and Salmon quadrangles (Idaho-Mont.) was checked. Geodetic distances and positions in the Wayan quadrangle (Idaho-Wyo.) were computed.

Primary level circuits in the Brownsville and Halsey quadrangles (Oreg.) were adjusted, and latitudes, departures, and geographic positions for the Cazadero and Oregon City (Oreg.) and the Portland and Troutdale (Oreg.-Wash.) quadrangles were computed.

A primary level circuit extending through the Desert Lake, Moab, Price, Provo, Salt Lake, Scofield, Tidwell, and Woodside (Utah), and Mount Wass and Westwater (Utah-Colo.) quadrangles was adjusted, and geodetic distances and positions for the Castlegate, Kyune, Ninemile Creek, Poison Spring, Sunnyside, and Wellington quadrangles (Utah) were computed. A spur line of levels in the Sunnyside quadrangle (Utah) was checked.

Primary level circuits were adjusted, and latitudes, departures, and geographic positions were computed in the Cedar Lake, Seattle, Snoqualmie, Sultan, and Tacoma quadrangles (Wash.), and latitudes, departures, and geographic positions for the Mount Rainier quadrangle (Wash.) were computed. Primary level circuits in the Moses Lake quadrangle (Wash.), run by the United States Geological Survey, and in the Pasco and Wallula quadrangles (Wash.), run by the United States Reclamation Service, were adjusted.

Geodetic distances and positions in the Soda Springs quadrangle (Wyo.) were computed.

Level lists were revised and assembled, after necessary computations and readjustments had been made, and transmitted to the editor for publication as bulletins for the following States: Arizona (Bulletin 463), California (Bulletin 481), Idaho (Bulletin 487), Nevada (Bulletin 488), Oregon (Bulletin 462), Utah (Bulletin 489), and Washington (Bulletin 457). The manuscript for the report on the Idaho-Washington boundary line survey was assembled and transmitted to the editor for publication as Bulletin 466.

#### INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

The field time of the inspectors was devoted largely to regular and special topographic work. J. H. Renshawe spent the early part of the season on inspection duty in portions of the Atlantic, Central, and Rocky Mountain divisions, and six weeks in the fall in topographic sketching in the Quarryville quadrangle (Pa.). W. M. Beaman examined and revised 600 square miles in the Flagstaff quadrangle (Ariz.), surveyed and inked in the field the Ray special map (Ariz.), and started control for the Miami special map (Ariz.). F. E. Matthes was engaged during the field season in topographic work on the map of the Mount Rainier National Park, completing 36 square miles.

The office duties of Messrs. Renshawe and Beaman involved a careful supervision of the inking and preparation of the final drawings of the topographic branch and their final examination prior to submission for engraving or photolithography. Mr. Matthes's time was devoted to the inking of his field work and to the revision of the book of instructions for the topographic branch.

#### INSTRUMENTS AND TOPOGRAPHIC RECORDS.

As in past years the repairs to all topographic instruments were made under the supervision of E. M. Douglas, who is also in charge of the topographic records.

The additions to the topographic records consisted of 263 triangulation or primary traverse books, 221 level books, nearly 300 vertical-



angle or stadia books, and 125 plane-table sheets, all of which have been numbered and catalogued. Four new iron filing cases for records were purchased.

#### MAP OF THE UNITED STATES.

Of the work begun last year on the 1:1,000,000 scale map of the United States, under the direction of A. F. Hassan, base maps of the following States have been completed: Vermont (portions of sheets K and L 18 and L 19), Massachusetts (portions of sheets K 18 and 19), Rhode Island (portion of sheet K 19), Connecticut (portions of sheets K 18 and 19), Michigan (portions of sheets K 16 and 17 and L 15, 16, and 17), Wisconsin (portions of sheets K and L 15 and 16), Minnesota (portions of sheets K, L, and M 14 and 15), Indiana (portions of sheets J and K 16), and North Carolina (portions of sheets I 16 and I and J 17 and 18). Seventy per cent of the lettering was completed on the New York and Pennsylvania portions of sheet K 18, and 80 per cent of the lettering on the Ohio portion of sheet K 17. The Ohio portion of sheet K 16 was lettered, completing the sheet, and 75 per cent of sheet J 18 was compiled and inked.

New work included the following:

Sheets K 14 and 15, Iowa portions, completed.

Sheets L and M 11, 12, and 13, Montana portions, 60 per cent compiled and inked.

Sheets K 12 and 13, Wyoming portions, 7 per cent compiled and inked.

Sheets H and I 15 and 16, Mississippi portion, 80 per cent compiled and inked.

Sheets H and I 16, the coastal plain area of Alabama, 80 per cent compiled and inked.

Sheet K 19, contours compiled for the land and ocean floor, and the sheet transmitted for engraving.

#### WATER-RESOURCES BRANCH.

##### AUTHORITY FOR INVESTIGATIONS.

The water-resources investigations of the year were made under the authority of the following clause in the sundry civil act:

For gauging the streams and determining the water supply of the United States and for the investigations of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources, one hundred and fifty thousand dollars.

The increase of \$50,000 in the appropriation for investigations of water resources permitted a considerable extension of this work during the fiscal year. It was necessary, however, in order to perform important land-classification work in the West (see pp. 68-72) to allot 82 per cent of the total appropriation for work west of the one hundredth meridian.

ALLOTMENTS.

The allotments of the appropriation for the fiscal year were as follows:

Administrative expenses of the survey.....	\$9, 179
Clerical assistance and supervision of work.....	11, 000
Purchase of supplies, telegrams, etc.....	800
Computations, reports, and technical studies.....	10, 500
Stream gagings in—	
New England and New York.....	8, 000
Virginia, South Carolina, North Carolina, Georgia, Alabama, Mississippi, and Tennessee .....	4, 000
West Virginia, Kentucky, Ohio, Indiana, and Illinois..	8, 000
Minnesota .....	6, 000
Texas .....	1, 000
Arkansas.....	1, 000
Stream gagings and water-power investigations in—	
Southern Wyoming, Colorado, and New Mexico.....	12, 000
Northern Wyoming, Montana, and North Dakota.....	9, 500
Idaho, Utah, and Nevada.....	11, 000
Washington and Oregon.....	12, 000
California .....	4, 500
Nevada and Arizona .....	6, 000
Stream gagings in Hawaii.....	5, 000
Investigations of ground water, including quality of water..	19, 500
Land-classification board .....	4, 000
Water-power investigations .....	6, 200
Débris investigations .....	800
Contingent .....	21
	<hr/>
	150, 000

COOPERATION.

STATES.

Cooperation with several States has been maintained as described in previous reports. The States and the amounts allotted by them are as follows:

*Amounts allotted by States for cooperative work with United States Geological Survey in investigations of water resources.*

California .....	\$9, 000. 00
Colorado.....	545. 00
Hawaii.....	5, 000. 00
Idaho .....	5, 000. 00
Illinois .....	3, 000. 00
Maine.....	1, 000. 00
Massachusetts .....	825. 00
New York .....	11, 089. 69
New Mexico.....	3, 170. 93
Oregon .....	2, 500. 00
Utah.....	2, 000. 00
Vermont .....	1, 000. 00
Washington .....	5, 000. 00
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	49, 130. 62

The work performed under these agreements is outlined in the following paragraphs:

*California.*—The determination of stream flow; the survey of reservoir, dam, and canal sites for the development of irrigation, water power, and municipal supply; the study of underground waters.

*Colorado.*—The determination of stream flow for use in the development of irrigation and water power.

*Hawaii.*—The determination of stream flow, the survey of reservoir sites, the measurement of precipitation, and the determination of the occurrence, quantity, and character of underground waters.

*Idaho.*—The determination of stream flow.

*Illinois.*—The determination of stream flow, especially low waters and flood heights, for use as a basis for the drainage of swamp and overflow lands.

*Maine.*—The determination of stream flow and the survey of reservoir and dam sites.

*Massachusetts.*—The determination of stream flow.

*New York.*—There are two cooperative agreements in force in this State—one with the State engineer, in which \$1,089.69 has been expended by each party for the determination of stream flow at points designated by the State engineer, and the other with the State water supply commission, in which the commission has allotted \$10,000 and the survey \$1,000, the money being devoted to the determination of stream flow for use in storage and the development of water power.

*New Mexico.*—The determination of stream flow for use in the development of water power and irrigation.

*Oregon.*—The determination of stream flow for use in the development of irrigation, municipal water supply, navigation, and water power.

*Utah.*—The determination of stream flow for use in irrigation and the development of water power.

*Vermont.*—The determination of the water resources of the State.

*Washington.*—The determination of stream flow for use in irrigation and the development of water power.

#### RECLAMATION SERVICE.

Cooperation has also been maintained with the United States Reclamation Service. The rivers supplying water to the reclamation projects under construction by that bureau must necessarily be investigated to determine the amounts of water that they will yield for irrigation. This work, being specifically applied to these projects, becomes a proper charge thereon, and the Reclamation Service has deemed it of advantage to utilize the Survey engineers for this purpose, paying to the Survey, through transfer of funds in the Treasury Department, the actual cost of the investigations. During the last year 96 stations have been maintained under this cooperative agreement.

#### OFFICE OF INDIAN AFFAIRS.

Cooperation has also been effected with the Office of Indian Affairs in connection with investigations of ground water. At the request of the Commissioner of Indian Affairs a study of ground-water supplies was undertaken in the Moqui and Navajo reservations of Ari-

zona, New Mexico, and southern Utah, \$1,500 being set aside for this purpose by the Indian Office.

Investigations of stream flow on Indian reservations have also been placed under the direction of the Geological Survey. The number of stations maintained under this arrangement is as follows: Idaho, 2; New Mexico, 3; Washington, 6; Wisconsin, 2. The cost of this work has been paid by transfer in the United States Treasury from the Indian Office appropriation.

#### FOREST SERVICE.

The cooperation with the Forest Service during the year was merely a cooperation of services rendered in connection with the determination of stream flow in selected national forests. Stations were established by the United States Geological Survey, and their maintenance, operation, etc., was undertaken by the officials of the Forest Service, under the supervision of the Survey. The number of stations maintained under this arrangement is as follows:

##### *Stream gaging stations in national forests.*

California.....	51
Colorado.....	59
Idaho.....	7
Montana.....	14
New Mexico.....	7
Oregon.....	20
Utah.....	13
Washington.....	16
Wyoming.....	7

#### PUBLICATIONS.

The work of the water-resources branch is represented by the following publications issued during the year: Professional Paper 72; Water-Supply Papers 237, 240, 246, 251, 253 to 258, 260, 262 to 265, and 270. Titles and brief summaries of these publications are given on pages 31-33. Water-Supply Papers 261, 266, 267 to 269, 271, 272 to 278, 286, and 288, and Bulletin 479 were at the Government Printing Office at the close of the year. Nine manuscripts are in hand awaiting editorial work, and 16 other reports are in different stages of preparation. Reprints of the following water-supply papers, the original edition of which has been exhausted, were ordered and delivered during the year: 165, 167, 168, 174, 175, 177, 180, 238, 239, 253, 255, and 260.

#### ORGANIZATION.

The organization of the water-resources branch has been changed during the year to conform to the new conditions and objects of work. The investigation of water-power sites, rights of way, etc.,

was first performed by the engineers of the division of surface waters in connection with their measurements of stream flow. This plan, however, resulted in a division of interest in both kinds of work, so that neither received the attention that it required, even to the extent of the small allotments available for the purpose. A new division was therefore organized, the members of which give their entire time to the land-classification work. The organization is now as follows:

M. O. Leighton, chief hydrographer.

Division of surface waters: John C. Hoyt, engineer in charge.

Division of underground waters: W. C. Mendenhall, geologist in charge.

Division of water utilization: M. O. Leighton, engineer in charge.

#### DIVISION OF SURFACE WATERS.

##### MEASUREMENTS OF STREAM FLOW.

The work assigned to the division of surface waters consists of the measurement of the flow of rivers in the United States, which is divided into 14 districts, as follows:

Maine district, covering only the State of Maine: C. C. Babb, district engineer, State capitol, Augusta, Me.

New England district: New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and New York. C. C. Covert, district engineer, Federal Building, Albany, N. Y.

Middle Atlantic district and computing section: Maryland, Virginia, and New Jersey. R. H. Bolster, district engineer, Washington, D. C.

Southeastern district: Alabama, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee. M. R. Hall, district engineer, Post Office Building, Atlanta, Ga.

Ohio Valley district: Illinois, Indiana, Iowa, Kentucky, Michigan, North Carolina, Ohio, Tennessee, Virginia, West Virginia, and Wisconsin. A. H. Horton, district engineer, Federal Building, Newport, Ky.

Upper Mississippi district: Minnesota and Wisconsin. Robert Follansbee, district engineer, Old Capitol Building, St. Paul, Minn.

Upper Missouri district: Montana, North Dakota, and Wyoming. W. A. Lamb, district engineer, Montana National Bank Building, Helena, Mont.

Denver district: Colorado, Nebraska, New Mexico, South Dakota, and Wyoming. W. B. Freeman, district engineer, Chamber of Commerce Building, Denver, Colo.

Great Basin district: Idaho, Utah, Wyoming, and Nevada. E. C. LaRue, district engineer, Brooks Arcade, Salt Lake City, Utah.

Columbia River district: Oregon, Washington, and Idaho. F. F. Henshaw, district engineer, Tilford Building, Portland, Oreg.

California district: California, Nevada, and Arizona. W. B. Clapp, district engineer, Federal Building, Los Angeles, Cal.

Texas district, covering only the State of Texas: T. U. Taylor, resident engineer, Austin, Tex.

Hawaiian district, covering the Territory of Hawaii: F. W. Martin, district engineer, Honolulu, Hawaii.

Alaskan district, covering the Territory of Alaska: C. E. Ellsworth, engineer in charge.

The results of the work performed in these districts are compiled and computed for publication by the computing section in the Washington office, under the charge of R. H. Bolster, assistant engineer. The distribution of the gaging stations by States is shown in the accompanying table, together with the number of stations established and discontinued and the number of measurements made. As a large part of the work is carried on in cooperation with other Federal bureaus, State organizations, and private parties, the table has been arranged to show the extent of such cooperation in each State.

At the end of the year the total number of stations maintained (exclusive of those in Hawaii and Alaska) was 1,105. During the year 107 stations were discontinued and 420 stations were established; 4,975 measurements were made at regular stations and 596 miscellaneous measurements were made. In addition to the foregoing, records ready for publication were received at the end of the year from private parties for about 100 stations.

*Gaging stations and cooperating parties for the fiscal year 1910.*

In Alaska 54 gaging stations were maintained in the Yukon-Tanana region for an average period of 143 weeks, furnishing data on the water resources of about 4,700 square miles; 15 gaging stations were also maintained for about 170 weeks in Seward Peninsula, yielding data on the run-off of approximately 1,800 square miles.

The data in connection with the investigation in the Territory of Hawaii have not yet been assembled for publication. Excellent progress, however, has been made in this Territory in spite of local difficulties.

The standard of the progress reports on stream measurements has been materially improved. The installation of a number of automatic gages of different patterns, each adapted to peculiar conditions, is also expected to make the records more accurate and to give a clearer insight into the laws governing stream flow.

Old-time records of stations maintained by the War Department and by the United States Weather Bureau are being carefully investigated and by means of discharge measurements made during previous years and complete studies and adjustments of the discharge data it will be possible to obtain for a large number of stations long-time records of daily discharge. The longest record thus far obtained is for Ohio River at Wheeling, W. Va., from 1838 to date. It is expected that these investigations will throw light on the much-discussed problems of the relation of run-off to precipitation and the effect of deforestation on river discharge.

To facilitate the use of Government reports relating to water supply, climate, and related subjects, the United States has, by agreement between the Geological Survey and the Weather Bureau, been divided into 12 areas and the progress report of stream gaging has been divided into 12 parts, each part covering one of these areas. The areas and the numbers of the corresponding reports giving the results for 1909 and 1910 are shown in the table below. The reports for 1910 have not yet been published.

*Reports on surface-water supply of the United States.*

	Water-Supply Paper No.	
	1909	1910
North Atlantic coast.....	261	281
South Atlantic coast and eastern Gulf of Mexico.....	262	282
Ohio River basin.....	263	283
St. Lawrence River basin.....	264	284
Upper Mississippi River and Hudson Bay basins.....	265	285
Missouri River basin.....	266	286
Lower Mississippi River basin.....	267	287
Western Gulf of Mexico.....	268	288
Colorado River basin.....	269	289
Great Basin.....	270	290
California.....	271	291
North Pacific coast.....	272	292



**RIVER-PROFILE SURVEYS.**

During the year all river-profile surveys were performed by the topographic branch, except certain incidental surveying in the upper Mississippi district by Robert Follansbee in St. Louis, Ottertail, Cloquet, and Vermilion rivers, and on certain rivers draining into Lake Superior.

**DÉBRIS INVESTIGATION.**

A report on the investigation of the natural laws governing the transportation of material of rivers has been in preparation by G. K. Gilbert. This is based on the results of nearly four years' laboratory experimentation in California, and the laws discovered by the studies will undoubtedly be extremely valuable to the engineering profession.

**DIVISION OF GROUND WATERS.**

At the beginning of the fiscal year 1910-11 an allotment of \$19,500 was made from the appropriation for gaging streams, to be used by the division of underground waters for investigating groundwater problems in the United States. In addition to this direct allotment, \$1,500 was set aside by the Office of Indian Affairs for a special study of conditions on the Moqui-Navajo Reservations in Arizona and New Mexico.

Of the direct allotment, \$2,000 was transferred to the geologic branch for use in the cooperative work carried on under the supervision of that branch in the States included in the Atlantic and Gulf Coastal Plain. The results of this work are summarized in the report of the geologic branch.

A small sum was set aside at the beginning of the year for completing the field work involved in the preparation of a report on California springs by G. A. Waring, who, as indicated in the last annual report, severed his connection with the Survey early in September, 1910. Previous to his departure, but during the present fiscal year, he spent a month in field work in California, completed the first draft of his manuscript, and delivered it for editorial revision and review. Some progress has been made in the work necessary to prepare it for publication.

R. B. Dole, assistant chemist, was assigned to the San Joaquin Valley, in California, where he spent three months in a study of the composition of the underground waters. Several hundred field assays and a smaller number of complete analyses were made and are now being assembled in the form of a report, which it is expected will be completed early in the next fiscal year.

In August the division of underground waters was strengthened by the transfer to it from the Reclamation Service of Herman Stabler,

qualified as a chemist and engineer. Mr. Stabler was assigned to the San Joaquin and San Jacinto valleys, in California, to study the results of experience in irrigation by the use of pumping plants, to determine especially the cost of pumped water under various conditions and the relative value of the different pumping devices in use. About 60 pumping plants were tested, and a report on the experiments in the San Jacinto Valley has been prepared. The report on the San Joaquin Valley work is as yet incomplete.

These two researches in the San Joaquin Valley are intended to supplement geologic and statistical studies of the development of the underground waters in this great valley, and their results will eventually be combined with the results of those studies in a general report on the area.

By cooperation with the city of Los Angeles, Cal., an investigation of the relation of ground-water supplies to run-off, on the one hand, and to loss through evaporation and other forms of drainage, on the other, has been undertaken in Owens Valley by Charles H. Lee. Careful measurements of all streams tributary to this valley and of evaporation from soil surfaces under various conditions of ground-water level have been made. It is expected that the report embodying the results of this work will constitute a contribution to our knowledge of certain fundamental facts involved in all ground-water problems—facts which heretofore it has not proved feasible to investigate, although their importance has long been recognized.

One of the most important single researches undertaken during the year is that of Sulphur Spring Valley, Ariz., extending from Douglas, on the Mexican line, northward beyond Willcox. This work has been undertaken as a result of a cooperative agreement with the Arizona Experiment Station, R. H. Forbes, director, and has been in charge of O. E. Meinzer, of the Geological Survey. It involves reconnaissance topographic work and careful studies of ground-water levels, of the costs of recovery by pumping, of the chemical character of the ground waters and of the soils, and of other facts bearing generally on the problems of irrigation by means of underground waters. The preparation of a report embodying the results of this research is well advanced toward completion at the close of the fiscal year.

At the beginning of the year a small allotment was made through the geologic branch to N. H. Darton to enable him to procure results that can be embodied in a water-supply paper on the area about Deming, N. Mex. This work was extended southward from Deming to a point within 15 or 20 miles of the Mexican border, but was not completed during the fiscal year. An additional small allotment will be made during the year 1911-12 to permit the completion of this work.

The report on the underground waters of Iowa, the preparation of which, in cooperation with the State Survey, has been under way for some time, was received in rough draft late in the fiscal year, and at its close is undergoing revision. Direct supervision over this report has been exercised by Prof. W. H. Norton, of Mount Vernon, Iowa, and the document will be issued as the joint product of the State and Federal surveys.

A similar report on the geology and water resources of Minnesota, submitted for publication during the previous fiscal year, has been advanced through the various stages of editorial revision and publication, and was issued just before the close of the present fiscal year.

C. H. Gordon, of Knoxville, Tenn., completed the rough draft of his report on the geology and underground waters of the Wichita region of north-central Texas during the year, and submitted it for revision and comment. This completes the series of reports that have been prepared for the Survey by Prof. Gordon.

The special investigations undertaken for the Office of Indian Affairs in the Moqui and Navajo reservations in Arizona have been carried out by Prof. H. E. Gregory, of the Survey staff and of Yale University. The results of these studies are not prepared for publication, but are presented in the form of manuscript reports intended to serve as practical guides to engineers and agents of the Indian Office. These manuscripts are transmitted directly to the Commissioner of Indian Affairs for his information.

A study of the quality of the surface waters of Washington, commenced in 1909, has been completed in cooperation with the Washington State Board of Health as one of a series of reports dealing specifically with the quality of the surface waters of the United States. The chemical laboratory for which quarters were courteously furnished by the University of Washington has been discontinued and a report on the work, to be published as a water-supply paper, is being prepared by Walton Van Winkle, who was in direct charge of the investigations for the Survey. Samples of water were collected daily for a year from the principal rivers of Washington at 17 stations and were united in sets of convenient number; the composites thus obtained were subjected to mineral analysis. In addition, determinations of turbidity, color, and alkalinity were made daily on several streams, and samples were also collected daily for six months at Albany, Oreg., from Willamette River, one of the largest tributaries of the Columbia. The results of these examinations as presented in Mr. Van Winkle's report furnish definite, reliable information regarding the chemical composition of the surface waters of Washington, the changes to which they are subject, and their availability as domestic and industrial supplies and for irrigation. Coupled with

other observations that have been made they supply means for estimating the rate of chemical denudation in the State and the conditioning effect of the geologic structure of the region.

In addition to the investigations outlined above, a large amount of miscellaneous work has been performed by the division during the year. R. B. Dole, for example, in addition to the California work for which he is directly responsible, has maintained general supervision over investigations of the quality of water in different parts of the United States and has revised chapters on the chemistry of water in all reports that have been submitted for publication. More or less of the energy of the division has been absorbed in making enlarged-homestead designations under the authority of the act of February 3, 1909, and in preparing reports on lists presented by the public-land States for segregation under the Carey Act. The results of work of this type have been presented through the land-classification board in the geologic branch.

#### DIVISION OF WATER UTILIZATION.

##### SCOPE OF THE WORK.

The work of the water-resources branch includes the investigation of power sites and other matters on the public lands; the investigation of water powers, floods, and river profiles, and the preparation of reports thereon for publication; the investigation of the run-off of rivers that drain lands proposed by the Secretary of Agriculture for purchase as national forests, and the interpretation of the data obtained to determine whether or not the control of such lands would promote or protect navigation.

##### WATER-POWER SITES.

A statement of the lands recommended either for withdrawal or for restoration for water-power sites, with all similar matters in connection therewith, such as reports on applications for right of way, enlarged-homestead designations, and Carey Act segregations, is given in detail in the report of the land-classification board.

During 1910 areas aggregating over 650,000 acres not previously examined were investigated by engineers of the water-resources branch in connection with water-power withdrawals.

The work of preparing reports on water-power sites and collateral matters is done in conformity with that portion of the sundry civil appropriation act providing for the preparation of "reports on the best methods of utilizing the water resources."

##### ACQUISITION OF LANDS.

Just before the close of the fiscal year investigations of stream flow were made in the White Mountain region of New Hampshire

to determine the relation of forest cover to stream flow. This region has been designated by the Secretary of Agriculture for purchase as a national forest, and the examination is being made in accordance with the requirements of the Weeks Act.

### **PUBLICATION BRANCH.**

#### **BOOK PUBLICATION DIVISION.**

##### **SECTION OF TEXTS.**

The publications of the year consisted of 1 annual report, 2 professional papers, 33 bulletins, 23 advance chapters from 5 bulletins, 16 water-supply papers, 54 advance chapters from the annual report on mineral resources for 1909, 7 advance chapters from the annual report on mineral resources for 1910, 5 geologic folios, 43 press bulletins, and a number of pamphlets. These publications were the Thirty-first Annual Report; Professional Papers 68 and 72; Bulletins 381 (published also in 4 advance chapters), 425 to 427, inclusive, 429, 430 (published also in 10 advance chapters), 431 (published also in 2 advance chapters), 432 to 447, inclusive, 449, 452, 453, 457, 459 to 463, inclusive, 465, and 7 separates from 470; Water-Supply Papers 237, 240, 246, 251, 253 to 258, inclusive, 260, 262 to 265, inclusive, and 270; 54 (all) advance chapters from Mineral Resources for 1909; 7 advance chapters from Mineral Resources for 1910; 5 geologic folios (published in folio and octavo form); a list of publications; a list of topographic maps and folios and geologic folios; "Regulations and instructions of the United States Geological Survey;" a chart showing mineral products of the United States, 1900-1909; a chart showing production of coal in the United States from 1814; and Press Bulletins 428 to 458, inclusive, and new series 1 to 7, inclusive (also 5 special issues). Titles and summaries of the publications of the regular series are given on pages 22-35.

The total number of printed pages in these publications was 13,566; the publications of the previous year comprised 12,855 pages.

During the year 40,648 pages of manuscript were edited and prepared for printing, and proof sheets for 17,417 final printed pages were read and corrected, this work involving the handling of 5,787 galley proofs and 32,706 page proofs. The corresponding figures for 1909-10 were 29,057 pages of manuscript, 12,517 final printed pages, 4,893 galley proofs, and 28,005 page proofs. Indexes were prepared for 74 publications, covering 14,400 pages; the figures for the previous year were 56 publications and 10,782 pages.

The press bulletin was prepared in this section until April 1, 1911.

The copy and proofs of all account and record books and blanks, circulars, office cards, etc., are examined in this section. This work consumes a large part of the time of one person, but it is not practicable to report the amount statistically.

The division of mineral resources, the water-resources branch, and the library rendered special assistance in copy preparing and proof reading.

At the close of the year the personnel of the section consisted of the editor, the assistant editor, 4 editorial clerks, and 1 stenographer and typewriter.

#### SECTION OF ILLUSTRATIONS.

During the year 3,990 illustrations were prepared and most of them were transmitted, to accompany 39 bulletins, 24 water-supply papers, 5 professional papers, 1 annual report, and 1 report on mineral resources. These illustrations included 267 maps, 1,119 diagrams, 1,720 paleontologic drawings, 4 landscape drawings, 587 photographs retouched, and 234 miscellaneous pieces.

The section received and compared critically 2,379 proofs, as well as all contract-printed inserts delivered at the Government Printing Office.

The number of electrotypes furnished to outside applicants was 157.

At the close of the year material for the illustration of 29 reports was on hand, 17 being from 50 to 90 per cent completed.

The personnel of the section consisted of 10 draftsmen (including the draftsman in charge) and 1 copyist clerk.

#### SECTION OF GEOLOGIC MAPS.

Twenty-two folios have been in hand in various stages during the year. Five folios (Nos. 172 and 174 to 177, inclusive), which are listed and described on pages 34-35, were published. The Foxburg-Clarion, Pawpaw-Hancock, Claysville, and Bismarck folios were completed with the exception of the printing of the descriptive text, and the maps of the Raritan, Choptank, and Llano-Burnet folios were nearly finished. The engraving of the Ellijay, Murphysboro-Herrin, and Kenova folios was begun. The Springfield-Tallula, Apishapa, and Colorado Springs folios were received for publication and the maps were in part prepared for engraving. Some editorial revision has been done on the San Francisco, Galatia, and other folio maps. The list of folios in course of publication and in preparation for publication, arranged in the order of progress, is as follows:

Foxburg-Clarion, Pa. (No. 178).	Kenova, Ky.-Ohio-W. Va.
Pawpaw-Hancock, W. Va.-Md.-Pa. (No. 179).	Apishapa, Colo.
Claysville, Pa.	Phillipsburg, Mont.
Bismarck, N. Dak.	Ellijay, Ga.-N. C.-Tenn.
Llano-Burnet, Tex.	Belleville-Breese, Ill.
Choptank, Md.	Springfield-Tallula, Ill.
Raritan, N. J.	Barnesboro-Patton, Pa.
<i>Murphysboro-Herrin</i> , Ill.	Eureka Springs-Harrison, Ark.
	Colorado Springs, Colo.



The geologic map of North America was edited and proof read, and three of the four sheets comprising it were printed. The sheet for the southeast quarter is in press and the edition will soon be completed. This is the largest map ever issued by the Geological Survey. Twelve colors are used to represent the geology, in addition to the two colors of the base, and the map is an effective piece of lithographic work. It also supplies a long-existing demand for a geologic wall map of the United States that is accurate as to detail within the scale of the map and that represents the true state of geologic knowledge.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 97 atlas sheets and special maps were on hand for publication, and the accessions during the year were 140—a total of 237 maps, of which 23 are fractional atlas sheets that average about 50 per cent completed. The following statement shows the status of these 237 maps on June 30, 1911, and the similar record on June 30, 1910:

*Status of work on maps, June 30, 1910, and June 30, 1911.*

	1911	1910
Published during the year.....	86	93
In process of engraving.....	56	57
Not taken up.....	95	40

The manuscripts edited during the year comprise 88 new topographic atlas sheets and special maps prepared for engraving and 3 maps prepared for photolithography; corrections for 205 sheets heretofore published; 6 maps published under contract; parts of sheets K 15, I 17, J 17, K 16, and K 17 of the millionth scale map; and 199 map illustrations which are or will be included in 39 survey reports. The proof read comprises 76 new atlas sheets and special maps, corrections to 55 old ones, and 16 maps published under contract.

A new edition of the topographic and geologic index map of the United States was prepared, proof read, and published. All but one of the 21 circulars of the series 9-323 were revised and reprinted during the year. The conventional signs adopted by the committee on unification representing the map-making bureaus of the Government were arranged and prepared for publication on one sheet. The lists of topographic maps were revised to date and proof read for a new edition of the pamphlet "Topographic maps and folios and geologic folios."

Five men were engaged in the work of this section during the year.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 136 new books, 5 folios, 80 new maps, 11 revised maps (4 of which were the results



of resurveys), 3 photolithographs, and 135 reprints of maps, a total of 370 publications. The total of all editions received was 498,886 books, 20,490 geologic folios, and 698,878 maps, a grand total of 1,218,254.

Reprints of the following publications were delivered to the Survey during the fiscal year: Bulletins 398, 406, 421, 424, and 431-A; Water-Supply Papers 165, 167, 168, 175, 177, 180, 238, 239, 253, 255 (two reprints), and 260; Mineral Resources of the United States, calendar year 1908, Parts I and II; and two advance chapters from Mineral Resources for 1909, namely, "The production of gold and silver in 1909" and "Petroleum operators' statistics of petroleum production."

During the year 488,930 books, 34,117 geologic and topographic folios, and 684,129 maps (including 517,777 sold), a total of 1,208,176, were distributed.

The total amount received and turned into the Treasury as the result of sales of publications was \$21,583.55 (\$19,230.20 of which was derived from the sale of topographic and geologic maps), an increase of \$381 over the amount received in the fiscal year 1909-10.

Fifteen persons were engaged in the work of this section.

#### DIVISION OF ENGRAVING AND PRINTING.

##### MAPS, FOLIOS, AND ILLUSTRATIONS.

During the year ending June 30, 1911, 86 topographic atlas sheets and special maps were published, and at the end of the year 56 sheets were in various stages of progress toward publication. Besides the engraved maps, sheets Nos. 1, 2, and 3 of Willamette Valley, Oreg., were photolithographed and published.

Corrections were engraved on the plates of 192 maps hitherto published. Editions of 231 maps were printed and delivered to the map room. This includes new sheets (engraved and lithographed) and reprints.

Five geologic folios were published, three of them in two forms, and 20,490 copies of seven different folios were printed and delivered. Six geologic folios were in press at the close of the year and four others had been partly completed.

Under contracts with the Government Printing Office, awarded on competitive bids, illustrations were printed for the following survey publications: Monograph LII; Bulletins 91, 108, 234, 239, 381, 398, 406, 430, 431, 435, 438, 440, 443, 445, 447, 448, 450, 452, 454, 456; Professional Papers 70, 71, 75; Water-Supply Papers 240, 275; Mineral Resources, 1909; Thirty-first Annual Report of Director.

For the Government Printing Office also the following items were printed and delivered: Illustrations for the American Ephem-

eris and Nautical Almanac, Annual Report Chief of Engineers United States Army, Annual Report Commissioner of Indian Affairs, Annual Report Superintendent of Coast and Geodetic Survey, Annual Report Isthmian Canal Commission, Annual Report Superintendent Yosemite National Park, Twenty-second Annual Report on the Statistics of Railways, eight Senate and House documents, Annual Report Superintendent Crater Lake National Park, Annual Report Governor of Alaska, Annual Report Governor of Arizona, Annual Report Commissioner of Corporations, Annual Report Board of Regents Smithsonian Institution, Third Annual Report Superintendent Block and Train Signal Board.

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 13 national forests, index map of the national forests of the United States, and map of North America showing natural forest regions; for the General Land Office, 964 township plats; for the Department of the Interior, maps of 2 national parks, 2 national monuments, 1 bird reservation, and 10 homestead maps of States and Territories; for the Reclamation Service, a large amount of miscellaneous work; for the Biological Survey, 3 maps of North America. Work was also done for the War Department, Navy Department, Department of State, Department of Justice, Department of Agriculture, Department of Commerce and Labor, Office of Indian Affairs, Isthmian Canal Commission, Bureau of Mines, Hydrographic Office, International Boundary Commission, Weather Bureau, Interstate Commerce Commission, Treasury Department, Army Service Schools, Tariff Board, and the District of Columbia. This work for other branches of the Government amounted to about \$48,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Of contract and miscellaneous printing of all kinds the total number of copies delivered was nearly 2,000,000 and required more than 4,500,000 printings. The total number of copies printed, including topographic maps and geologic folios, was 2,555,230, requiring nearly 8,000,000 impressions. On requisition of the Government Printing Office 351 transfer impressions were made and shipped to contracting printers.

#### INSTRUMENT SHOP.

The work of the instrument shop consisted of repairing surveying, drafting, engraving, stream-gaging, and other instruments and making copper plates and electrotypes. More than 1,200 repairs and overhauls were made, 79,755 square inches of new copper plates were made and 954 square inches were resurfaced, and 10,710 square inches of electrotypes were made.

**PHOTOGRAPHIC LABORATORY.**

The output of the photographic laboratory included 16,004 negatives, of which 11,603 were dry, 3,342 were wet, and 1,059 were paper; and 40,748 prints, of which 16,331 were maps and diagrams and 24,417 were photographs for illustrations.

**ADMINISTRATIVE BRANCH.****EXECUTIVE DIVISION.**

The work in the executive division was of the same scope as in other years, except for the transfer of the administrative bookkeeper to the division of disbursements and accounts. Considerable time was given by the chief of the division and two clerks to reports on various subjects for the use of the President's Commission on Economy and Efficiency. A special file of these reports and of the correspondence relating to them is maintained.

In many items the work performed by the division shows increase, in spite of the separation of the Bureau of Mines from the Geological Survey. The decreases mentioned below are due in large part to that separation.

*Mails, files, and records.*—During the year 134,386 pieces of incoming mail were handled in this division, an increase of 1 per cent over the number handled in the preceding fiscal year. Of this number 2,590 were registered, which is an increase of slightly more than 10 per cent over the preceding year. This number does not include the pieces of mail distributed unopened to the several branches, divisions, sections, and individuals in the Survey. Since March 1 a record of mail distributed unopened has been kept, and the number of pieces of such mail handled during the four months was 99,158.

Of the letters opened in this division, 26,076 contained remittances for Survey publications, a slight increase over the number of similar letters received during the last fiscal year, but the amount of money received, \$23,790.18, is \$68.68 less than last year.

The recording, referring, and filing of correspondence required the services of 5 clerks throughout the year. The number of letters mailed through the division was 92,126, an increase of about 8 per cent. Of this number 20,951 were registered, which is an increase of 73 per cent.

*Personnel.*—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 862 persons, compared with 958 at the close of the fiscal year 1909–10. The total number of changes in the personnel for the year was 1,119, which included original appointments, separations, promotions, extensions, and changes of status of every description. Of these, 275 were new appointments, 370 were separations (including 53 transfers to the

Bureau of Standards and 140 transfers to the Bureau of Mines, organized July 1, 1910), 375 were promotions, and 6 were reductions.

During the year 12,794 days of annual leave and 3,396 days of sick leave were granted, being about 68 per cent of the amount of annual leave and 18 per cent of the amount of sick leave which it is permissible to grant under the law; also 3,239 days of leave without pay. In addition to the above there were 203 transfers to State pay rolls in cooperative work.

*Property.*—An inventory of nonexpendable property in Washington was submitted to the department at the close of the calendar year 1910.

*Express and freight.*—During the year 4,009 pieces of freight and express were handled, of which 1,427 were outgoing and 2,582 were incoming. This was a decrease of 10 per cent in the number of pieces handled. There were 451 transportation accounts checked, a decrease of about 20 per cent.

A change was made in the method of recording express and freight shipments so as to segregate the outstanding transportation accounts in the card record. Except for the rearrangement of the cards, which has been completed, this involved no additional clerical work, and it facilitates the checking of transportation accounts.

*Purchase and distribution of supplies.*—The purchase and distribution of supplies, which includes the work of procuring bids, issuing orders, and preparing vouchers covering all purchases in open market, required the services of 3 persons. The number of requisitions handled was 2,157, an increase of more than 7 per cent.

*Stationery.*—There were 7,148 requisitions filled from stock in the stationery room. The requisitions drawn on the department numbered 330 for miscellaneous supplies, 184 for stationery, and 430 for printing. These figures show an increase over those for 1910, except in requisitions for stationery and printing drawn on the department, and the decrease in those items is accounted for by the fact that the requisitions called for larger quantities than those drawn in previous years.

During the last half of the year the work of the stationery room has been reorganized. A simple but effective system of records has been established, including a stock record which shows at all times the condition of stock on hand and a file of requisitions by branches and divisions. Several new forms have also been issued, including invoices to accompany shipments of stationery supplies to the field and orders to indicate shortage of supplies which are out of stock. On account of assignments to other work, illness, and other causes the force in the stationery room has varied during the year, but it normally consists of 4 men, including the clerk in charge of the property records.

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below :

*Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1911.*

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of the Director.....	\$34,860.00	.....	\$34,860.00	\$34,591.98	\$268.02
Salaries, scientific assistants.....	29,900.00	.....	29,900.00	29,899.90	.10
Skilled laborers, etc.....	20,000.00	.....	20,000.00	19,988.64	11.36
Topographic surveys.....	350,000.00	\$5,735.14	355,735.14	354,211.13	1,524.01
Geologic surveys.....	300,000.00	53,818.73	353,818.73	348,694.85	5,123.88
Mineral resources of Alaska.....	90,000.00	33,021.88	123,021.88	122,801.91	219.97
Chemical and physical researches.....	20,000.00	18.20	20,018.20	19,911.28	106.92
Preparation of illustrations.....	18,280.00	.....	18,280.00	18,250.67	29.33
Mineral resources of the United States.	75,000.00	65.60	75,065.60	74,235.26	830.34
Gaging streams, etc.....	150,000.00	23,944.69	173,944.69	172,853.95	1,090.74
Books for the library .....	2,000.00	.....	2,000.00	991.29	1,008.71
Geologic maps of the United States....	100,000.00	54,166.75	154,166.75	144,294.03	9,872.72
Surveying national forests.....	75,000.00	89.55	75,089.55	73,560.35	1,529.20
	1,265,040.00	170,860.54	1,435,900.54	1,414,285.24	21,615.30

The following table gives the classified net expenditures by the Survey for the fiscal year, the repayments shown in the preceding table having been deducted :





## LIBRARY.

The library has received during the year, by purchase and exchange, 11,388 books and pamphlets and 875 maps, some of which are of temporary value only and will not be recorded as accessions to the permanent collection. The exchanges received during the year were notably valuable. A careful estimate shows that the library now contains 86,000 books, 100,000 pamphlets, and about 100,000 maps. Accessions are restricted as closely as possible to publications that consider subjects within the scope of the Survey's work and that will probably be of permanent value. Publications on other scientific subjects are transferred to the Library of Congress. Notwithstanding the efforts to confine the increase to the narrowest limits consistent with usefulness, the need of additional shelf room is now urgent.

The number of persons consulting the library during the year was 7,873, and 10,326 books and 521 maps were loaned for use outside.

Of the current receipts all material which is unquestionably of permanent value to the library is promptly recorded by full titles in the author and subject catalogues. Other material is recorded in briefer manner, classed, and shelved where it is available for use. During the year 5,812 volumes and 631 maps were catalogued.

Additions to the card catalogue during the year numbered 6,976. The Survey continues to furnish to the Library of Congress for printing on its cards the catalogue entries of geologic publications; of these entries 733 were supplied during the year.

The correspondence consisted of 4,528 letters received and 3,495 letters written and related largely to the exchange of publications. The demand for the publications of the survey is very active in the educational and scientific institutions throughout the world which have departments of geology or are interested in the subjects covered by the reports. The list of institutions to which full sets are distributed now numbers 355 in the United States and 582 in foreign countries, a total of 937. Publications that are of value to the library are received in exchange from most of the institutions on this list. The authorized distribution of the Survey publications from the office of the superintendent of documents, Government Printing Office, supplies public and school libraries and other institutions which have no exchange agreements with the Survey, and duplication of distribution is carefully avoided. To an additional list of 508 persons and institutions, domestic and foreign, selected publications are furnished in return for certain of their own publications supplied to the library. The gratuitous distribution of the topographic sheets to libraries is now practically up to the authorized number—500. The geologic folios are furnished to 375 libraries, in addition to the



depository libraries, which receive the folios from the superintendent of documents, Government Printing Office.

The bibliography of North American geology for 1909 was completed and issued as Bulletin 444. It contained 1,305 author entries, an increase of 90 over the volume for 1908. The bibliography for 1910, with 1,410 author entries, will be ready for the printer in July, and will be published as Bulletin 495. A part of the time of the assistant librarian has been devoted to the preparation of indexes and of data to be incorporated in Professional Paper 71 ("Index to the stratigraphy of North America").

The personnel of the library consisted of the librarian, the assistant librarian, 2 cataloguers, and 3 other persons.

A fire in the store directly under the Survey library on Sunday afternoon, July 31, 1910, greatly endangered the library. Fortunately no books were destroyed, but the bindings of 200 or more were seriously damaged.



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DEPARTMENT OF THE INTERIOR  
UNITED STATES GEOLOGICAL SURVEY  
GEORGE OTIS SMITH, DIRECTOR

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THIRTY-THIRD ANNUAL REPORT  
OF THE  
DIRECTOR OF THE UNITED STATES  
GEOLOGICAL SURVEY  
TO THE  
SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR  
ENDED JUNE 30

1912

WASHINGTON  
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1912





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# THIRTY-THIRD ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

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GEORGE OTIS SMITH, *Director.*

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The appropriations for the work of the United States Geological Survey for the fiscal year 1911-12 comprised items amounting to \$1,507,920. The plan of operations was approved by the Secretary of the Interior and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

## **SPECIAL FEATURES.**

### **NEED OF A SURVEY BUILDING.**

#### **GENERAL UNFITNESS OF BUILDINGS NOW OCCUPIED.**

The record of the work of the Geological Survey during the fiscal year 1912 may fitly be preceded by a statement of the conditions under which that work has been done, not as an apology for either the quantity or quality of the results of the investigations made, but rather as an exhibit of the limitations forced upon this bureau—limitations on economy and efficiency which seriously hamper all efforts for better administration in the expenditure of public money.

The offices of the Geological Survey have become wholly inadequate and unadapted to its needs. Since 1884, when the Survey was first quartered in the Hooe Building, at 1330 F Street, the effort has been frequently made to provide for the growth of the organization by adding wings and extensions to the building, but every increase in floor space has been made at the expense of proper lighting of the older portions of the building, so that its fitness for the Survey's use has been steadily impaired, and the resultant conditions constitute an actual detriment to health and a menace to life and property, as well as an obstacle to efficiency. The conditions under which the Survey employees work in the Washington office are to be condemned for both humanitarian and business reasons.

## EFFECTS OF CROWDED OFFICES.

Under the humanitarian clause of the indictment the present quarters of the Geological Survey can be described without exaggeration as in large part comparable in crowded and insanitary conditions to a sweatshop. Treatment of wage earners that would excite severe criticism if a corporation were the offender is tolerated in the case of these employees of the Federal Government. The crowded condition of the building occupied by the Geological Survey is so manifest to every observer that it needs to be described only for the information of those who have not had occasion to visit the offices.

In one division of the Survey statistical clerks have each on an average only 73 square feet of floor space. In another branch of the Survey the floor space allotted to each person is  $67\frac{1}{2}$  square feet, and in still another section, in which the workers are for the most part scientists, the average space per man is 102 square feet. The figures given do not measure the actual working space available, for not only must desks and chairs be provided, but also bookcases, large file cases, and in many rooms drafting tables.

## LACK OF FRESH AIR AND LIGHT.

The congestion will become more apparent if the ventilation and lighting of these rooms are considered. If instead of floor space the cubic capacity of the rooms occupied is measured, it is found that the average volume of air per person is about 652 cubic feet, again without allowance for the considerable space occupied by furniture and therefore not available for air. Certain more or less definite standard minimum requirements for cubic contents have come into use for various classes of public buildings, these requirements being based on the customary allowances for fresh air. Thus public libraries are planned with not less than 2,400 cubic feet, hospitals with a minimum of 1,440 cubic feet, and barracks with not less than 720 cubic feet of space per occupant. The average cubic space available for each person occupying the Survey rooms is therefore below even the minimum allowed in barracks and only a fraction of that allowed in other buildings. Indeed, in five of the Survey rooms, each with two occupants, the allowance is less than one-half of the minimum required for barracks. When the ventilation of these particular rooms is taken into account the showing is even worse, for more than half the windows open into interior wells and the rest into alleys, and no system of artificial ventilation is provided, these conditions unfortunately being typical for a large proportion of the Survey rooms.

In the matter of lighting the conditions are no more favorable. In one of the divisions already cited the average window space per clerk

is two-fifths of a small window, and here again many of the windows open into interior wells, so that in most of the rooms artificial light is necessary on dark days and even for several hours on clear days in winter. The generally crowded condition has compelled the occupancy of several rooms in which artificial light must be used practically all the time. In one of the scientific sections the largest floor space assigned to one man—162 square feet—is in a room where the light is so poor that artificial illumination is needed most of the time, and the strain on the occupant's eyes is so great that rotation in assignment to this office is practiced in order that permanent injury to any one employee may be avoided if possible.

While permanent or temporary injury to the eyesight of some of the geologists and draftsmen can be definitely traced to the poor lighting of the rooms in which they have been forced to work, it is more difficult to trace the results of insufficient ventilation. That the unhygienic conditions prevailing in the building occupied by the Survey must necessarily lower the tone of the health of its employees is apparent. The customary standards for ventilation provide for a minimum of 1,000 to 3,000 cubic feet of fresh air per hour per occupant. It is doubtful whether, under the conditions prevailing in the Survey's offices during the winter, the supply of fresh air averages 600 cubic feet per hour per occupant, which is only 20 per cent of the quantity required by the higher standard now widely used to provide a proper factor of safety for the health and efficiency of employees. Without considering the effects of dust and noise, to which the employees of the Survey are subjected by reason of the location of its present quarters, it is certain that the overcrowding, resulting as it does in lack of proper lighting and ventilation, must seriously impair the health of these Government employees.

The results of this violation of practical hygiene would be more widespread and more apparent were it not for the fact that a considerable number of the members of the Survey are field men, whose work during the summer is performed in the open air where they have opportunity to recuperate each year. This open-air work may protect certain members of the force from lung disease and from defective vision, but it does not make the congested conditions seem any more tolerable to a geologist or topographer who has been assigned 1,000 square miles for five months of field service and is obliged to work the remaining seven months of the year with an allowance of 100 square feet of floor space.

#### ROOMS TOO HOT FOR OCCUPANCY.

The top floor in the main building of the Survey and the loft in the annex becomes so hot in the summer that at times it is impossible for the employees occupying these floors to perform their duties,



and indeed they frequently have to be assigned to work elsewhere. The larger part of the top floor, however, is for this reason occupied by field men, who usually are absent from Washington during the hot weather. In the loft of the annex, an old building in an alley, the summer temperature runs as high as 110° F., and neither the employees nor the solutions and emulsions used in the photographic laboratory there can be depended on for high-grade results under these conditions.

#### THE FIRE RISK.

A menace second only to the existing danger in health is the risk to public records. Estimates have been made at various times of the money value of the records necessarily stored in the Survey building. The latest inventory shows a present value of \$4,840,000, and this value represents largely the amount that would necessarily be expended in duplicating the unpublished material and in replacing the large stock of map plates which could be reengraved from published maps. Moreover, there is a sense in which the loss in official records can not be estimated in dollars. The detailed stream-gaging records for 20 years could not be replaced except by another 20 years of observations, and similarly, unpublished geologic data contained in notebooks and plats and represented by the working collections of specimens could hardly be replaced, except in an equal length of time. The land-classification work of the Survey is now proving how invaluable are these unpublished data, accumulated during the last 33 years, and a destructive fire in the wing of the building occupied by the land-classification board would destroy records whose loss would long delay the issuing of land patents throughout the public-land States.

The Survey library is a collection of geologic literature that in degree of completeness can not be duplicated elsewhere in this country, if indeed in the world. This library therefore has a value which can not be easily estimated, since, if destroyed, it could not be wholly replaced, and such portion as is replaceable could be duplicated only at great expense of time and public money.

It is believed that every safeguard against fire that is possible through an efficient watch service and the careful distribution of fire extinguishers has now been provided, but the fact remains that although the building is constructed of iron and brick it is honey-combed with light wooden partitions, which present some 2 acres of surface that could be easily ignited. Even if these wooden partitions should be replaced with fireproof ones the building would still be classed with the third-rate risks because of the lack of protection of the bottom flanges of the I beams that support the floor arches. A fire once started in this large amount of inflammable material would

result in quick buckling of the unprotected iron beams, and the consequent collapse of the floors would make the fire hard to fight.

The exterior fire risks should also be considered, inasmuch as all the buildings in the block, except two, present even greater fire risks than the building occupied by the Survey. During the last nine years there have been four fires in the Survey building, and it is notable that the latest fire, which occurred on a Sunday, originated on the first floor of the building, in a store over which the Government has no jurisdiction, although the fire was discovered by a Survey watchman, and the spread of the fire in the Survey library was checked only by the efforts of the watchmen and the members of the Survey who happened to be in the building at the time.

#### RESULTS OF OFFICIAL INSPECTION.

On April 14, 1911, an inspection of the Survey buildings was made at the request of the Director by the District fire marshal and inspector of fire escapes, whose detailed report presents suggestions for the better protection of the occupants in case of fire or other emergency. On April 25, 1911, a further inspection was made by a special subcommittee of the House Committee on Public Buildings and Grounds, accompanied by the chief engineer of the fire department. Both inspections convinced those who made them that the buildings were unadapted for Government use and resulted in certain recommendations, which have been put into effect, except one by the fire marshal that the use of the annex loft be discontinued because it is "utterly unfit" for the purpose for which it is used.

#### IMPAIRMENT OF EFFICIENCY.

The third great objection to the longer continuance of the Survey in these rented quarters is a practical one. Maximum efficiency is impossible with such congestion and the attendant inadequate ventilation and lighting and with the impossibility of systematically arranging the offices and working collections; and the dirt and noise consequent upon the Survey's location at the very business center of Washington present further obstacles to economical administration. The whole situation not only results in less efficient use and hence in actual waste of Government money, but also on that account creates a feeling of dissatisfaction and discouragement among the highest class of scientists and other members of the Survey, who wish to make the largest and best contribution possible to the public service.

The present overcrowding has already been considered with respect to hygiene, but the consequent loss in efficiency is greater than that measured simply by impairment in health. Tests have shown that

light suitable for clerical or technical-clerical work fails at approximately a distance of 15 feet from the window line, yet 12½ per cent of the floor space occupied in the main building is more than 15 feet from the windows, and this computation is based on the assumption that the windows in the light wells are as effective for lighting as are those on the exterior walls. If, however, a lighting factor of 50 per cent is assumed for the well windows on the lower floors, an estimate which appears to be liberal, the space unsuited for clerical work in the building is found to be 33.8 per cent. It is evident that both the quantity and quality of work performed in the poorly lighted portions of these rooms must fall far below the standard that could be attained with better lighting.

In a similar way with the deficiency in ventilation: even where the presence of various noxious gases does not actually result in pronounced ill effects on the health, the lack of pure air results in relative inefficiency in the mental processes of employees subjected to the conditions described.

#### INCONVENIENCE DUE TO LACK OF PROPER SPACE.

The crowding of the Survey building precludes a systematic arrangement of offices and of working material, including specimens, notes, and maps, that should be close at hand for repeated reference. Specimens, for instance, are stored not only in the offices of the geologists but also in the halls, and where the limit of floor safety has been reached for such storage, collections are packed up and placed in the cellar, where they can not with any propriety be called accessible.

Sections and divisions in the Survey which should be close together are now far apart, and even the members of the same part of the organization are scattered in different parts of the building. The growth of the topographic branch has necessitated the renting of additional quarters in another building, into which a portion of the technical force has overflowed. Another instance of undesirable separation of related sections is seen in the fact that the offices of the editor of texts and the chief of the section of illustrations, who should be in frequent consultation, are necessarily located in widely separated parts of the building. Similarly, most of the paleontologists, whose work is closely connected with that of the other geologists and who should be, therefore, in close touch with them, have been crowded out of the Survey building and have been quartered in the National Museum, through the courtesy of the Secretary of the Smithsonian Institution. This separation of men engaged in researches which ought to be closely correlated is seriously retarding the scientific work.

## DIRT AND NOISE FROM WITHOUT.

The location of the building occupied by the Survey on the busiest street in town brings its attendant evils of dirt and noise. Not only do the neighboring chimneys pour out soot and fine cinders that keep the books, files, and records covered with dirt, but on three sides the building is bordered by a street and alleys, which are a constant source of additional dirt and also a source of noise. These alleys, which afford access to a theater, two newspaper offices, a hotel, an office building, and several saloons, necessarily have an almost constant traffic of heavy wagons, and the noise of these passing up and down the cobblestones is deafening; the only variations are the rehearsals of a summer opera company and the chorus of yells by newsboys who congregate at the rear of the Survey building awaiting the various editions of an afternoon paper.

The street noises in the summer, when the windows must be opened, are so great and annoying that it is at times impossible to use the rooms on F Street for dictation to stenographers, and to use the telephones in those rooms it is often necessary to close the windows temporarily. The almost constant passage of heavy cars along F Street, in front of the building, sets up vibrations so great that at times scientists wishing to use delicate instruments have been obliged to do such work at intervals after midnight, and even then the effect of vibration was not wholly avoided.

## DISTRACTING NOISES IN THE BUILDING.

In addition to the prevalent noises of exterior origin, which constitute a great drawback to intellectual work, there are interior noises, inevitable upon the crowded condition of the building—noises that are amplified or intensified by numerous wooden partitions, which constitute excellent sounding boards.

The common arrangement of placing a stenographer in a room occupied by a high-salaried man engaged in scientific investigations is not to be commended for its efficiency, yet the present congestion is so great that relatively few of the geologists are ever free from the distracting noise of the typewriter. In the computing section of another of the scientific branches six or seven hydraulic engineers are crowded into a single room, together with an adding machine or two. Inasmuch as hydraulic computations require constant attention and freedom from diverting noises, it is plain that larger quarters and some degree of isolation would facilitate the work. A careful estimate places the possible increase in efficiency at 30 per cent, which would represent an annual gain of several thousand dollars in this one section alone.

**INCREASE OF EFFICIENCY POSSIBLE UNDER BETTER CONDITIONS.**

Several other estimates have been made by the administrative officers of the Survey of the increased degree of efficiency that could be attained by changing the quarters for the various classes of employees from indifferent or worse to suitable accommodations. The estimated increase ranges from 15 to 30 and even to 50 per cent. A significant statement, based on recent experience, is made by one of the geologists. While quarantined at home he continued his Survey work in a large, well-lighted, clean, and quiet study and found, as a result of this practical test of doing the same kind of work under these different conditions, that he could accomplish 50 per cent more than in his Survey office, which happens to be one of the best in the building. This increase was in part attributable to freedom from interruption, but it is believed to be largely due to better light and air, lack of crowding, and freedom from noise.

**PRESENT QUARTERS OF SURVEY UNWORTHY.**

Another argument for a special building is hardly less practical in its ultimate bearing. The present housing of this Federal bureau is unworthy of the Nation. Both the work and the workers of the United States Geological Survey have an international reputation, and visiting foreign scientists do not conceal their astonishment at the miserable environment in which these investigations are being carried on. Our neighbors on this continent, in Canada and Mexico, have erected buildings especially adapted to the work of their geological surveys, which are properly housed, as is nearly every other geological survey in the world, and yet the geological survey of no other nation compares in size of organization or scope of work with that of the United States. In fact, the surveys of several of the larger European countries are organizations whose personnel is comparable in number only with that of single divisions of the American Survey.

The practical side of this feature is the increased inducement that suitable quarters would afford in retaining in the Government service men of the highest professional talent. At best, most of these investigators are carrying on their Government work at a financial sacrifice, and the temptation to go into professional or corporation work at largely increased salaries is strengthened by the contrast between the well-lighted and sanitary offices generally provided in the business world and the noisy, dirty, dark, and crowded quarters offered by the Survey. To retain in the Government service the best men is by far the largest administrative problem of the Director of the United States Geological Survey.

## STATUS OF LEGISLATION FOR NEW BUILDING.

The present status of the legislation providing for the erection of a building for the Geological Survey may be briefly stated. After efforts extending over 27 years an item authorizing the construction of a building was included in the sundry civil appropriation bill as reported to the House of Representatives at the second session of the Sixtieth Congress, but it went out on a point of order. In the same year (1909) the House Committee on Public Buildings and Grounds unanimously reported a bill making the same provision, but this also failed of consideration. Similar favorable recommendation from this committee had been reported as early as 1889. The public buildings act approved June 25, 1910, however, directed (in sec. 32) the preparation of designs and estimates for a building for the accommodation of the Geological Survey and other bureaus of the Interior Department and made available for this purpose a balance of \$96,506.20 remaining from an appropriation originally made for the purchase of the square bounded by E, F, Eighteenth, and Nineteenth Streets NW., on which, by the terms of the act, the proposed building is to be erected. On May 20, 1911, the Secretary of the Treasury transmitted to the Speaker of the House of Representatives sketches prepared for such a building, with five preliminary estimates of cost, ranging from \$1,950,000 for a three-story brick building to \$4,900,000 for a seven-story stone building. The larger amount is approximately the same as the replacement value of the public property that would be safeguarded by the erection of such a building and that is now exposed to the considerable fire risk in the Survey's present quarters. The act authorizing these estimates specifies a "fireproof building of modern office-building type of architecture." These plans and estimates were referred to the House Committee on Public Buildings and Grounds of the Sixty-second Congress.

## PROGRESS OF SCIENTIFIC WORK.

## CONTRIBUTIONS OF ECONOMIC WORK TO "PURE SCIENCE."

Notwithstanding the growth of the Survey work along practical economic lines, scientific work has not been neglected. In fact, in the Geological Survey the scientific investigations are inseparable from the economic work, though the one or the other may predominate in purpose according to the needs of the particular research in hand. In any field economic work of the highest rank is impossible without full knowledge of the scientific laws and principles pertaining to the subject of the work; but as there is no application of geology which does not involve unsolved problems, some of them of the highest importance, the best knowledge available is nevertheless rela-



tive. It thus follows that the broad and searching observations which should accompany every piece of good economic work comprehend data that are eventually combined in the construction of new scientific hypotheses, some of which, as more observations accumulate, grow into established laws or principles that are in turn of the greatest practical consequence. Thus the detailed studies of the metalliferous deposits in one region or another bring to light evidence from which to determine the genesis of the ores and the modes or conditions of their occurrence, and the economic inquiry becomes more intelligent and successful when once this new principle regarding the mode of an ore occurrence is understood.

On account of the plain duty of this Federal service to minister to the immediate needs of the various mining districts, it is not generally possible to concentrate and direct the observations to a series of regions systematically chosen as suited soonest to furnish the requisite data bearing especially on some particular scientific problem, however important and advantageous its solution may be; but nevertheless the data are gradually accumulated for the interpretation of many of these problems without sacrifice of the Survey's obligations to the public. An interesting illustration of the deduction of a principle from data so accumulated is found in the paper by W. H. Emmons on the enrichment of sulphide ores, the manuscript of which has been completed during this year. Another illustration of scientific results based on a long period of field studies, pertaining mainly to economic areas, is found in the pre-Paleozoic history of central North America, as described in the monograph by Van Hise and Leith on the geology of the Lake Superior region, which appeared during the year.

Among other long-term studies more distinctly scientific in character may be mentioned particularly the investigations, made under Mr. Vaughan's direction, of the formations of the southern Coastal Plain and Gulf embayment, which, though having an economic object, are yielding important contributions to our knowledge of the stratigraphy, physiography, and geologic history of this province; the work under the direction of Mr. Cross in the San Juan region of southwestern Colorado, which, in connection with the thorough geologic studies made during the preparation of folios, is affording new scientific results of a high order concerning especially the volcanism and physiography of the region; and the studies begun last year by Messrs. Campbell and Alden in the Glacier National Park, which promise important results concerning the origin of the structure and physiography of this part of the Rocky Mountains and of the glacial topography, which, as it is still "in the making," offers exceptional opportunities for scientific study as well as observation by the traveler interested in the natural wonders of his own



country. Important regional studies of high scientific rank which should also be mentioned are those prosecuted by Mr. Keith and his associates, on the difficult stratigraphy and intricate geologic structure of the older Paleozoic regions of western New England and the Appalachian region, the results of which are partly published in folio texts, and those carried on by Prof. Emerson in southern New England. A report by Prof. Emerson on the geology of Massachusetts and Rhode Island has been submitted during the year.

#### PALEONTOLOGIC WORK.

The paleontologic work of the Survey continues to be of the highest rank. Many of its publications, written by the most distinguished representatives of the various branches of paleontology in the country and embodying experience and observations gathered during years of patient research, have contributed much to the scientific reputation of the organization. The descriptive paleontologic papers are often treated as "pure science;" yet instructive, striking, or tedious as may be these delineations of the groups of animal or plant life which lived on the globe in some particular epoch, there is not one of these papers describing the fauna or flora of a formation that does not prove sooner or later to possess practical value and to be essential to geology in its constantly increasing refinement of study and results. Without paleontology the geologic classification of formations, their correlation, and the determination of their mutual relations would be impossible. In fact, real and symmetrical progress in geology is impossible without corresponding interrelated development and refinement of its handmaid paleontology. The economic geology of any region of complicated structure is blind and inconsequent unless the time relations of the strata concerned are known. The monograph now being issued from the press on the Cambrian Brachiopoda, prepared by ex-Director Walcott and representing many years of painstaking study and distinguished attainment, embraces our best and most complete presentation of the criteria for the discrimination of the Cambrian formations in America and will for many years be a manual for the use of workers in Cambrian geology and paleontology. This monograph brings deserved credit to American science and to the Geological Survey, under whose auspices most of the work was accomplished. Other paleontologic publications specially deserving mention by reason of their scientific merit are J. P. Smith's philosophic treatment of the Middle Triassic faunas, and the monograph on the Mesozoic and Cenozoic Echinodermata of the United States by W. B. Clark and M. W. Twitchell, the manuscripts for both of which are now in hand. Works like that of Kindle on the Onondaga

fauna, lately printed, and those by Berry on the Upper Cretaceous and Eocene floras of South Carolina and Georgia and by Stephenson on the Cretaceous deposits of the eastern Gulf region, both now in manuscript, are indispensable to geology. In these papers the stratigraphic value and the practical application of the results of the paleontologic investigations are given much prominence. The two papers last named are based on materials gathered in the course of the study of the Coastal Plain already mentioned, the economic motive for which was the investigation of the underground water resources. They are therefore representative of a series of scientific reports resulting from studies whose immediate object is economic.

#### WORK ON GEOLOGIC FOLIOS.

The folios describing and mapping in detail the geology of quadrangles in different parts of the country are regarded as mainly scientific, though always giving attention to the economic resources of the region. The areal studies now in progress in the valley region of central Alabama, a part of which has been described by Mr. Butts in the Bessemer-Vandiver and Montevallo-Columbiana folios, now in hand, promise important additions to the geologic history of the southern Appalachian region. On the other hand, the Claysville (Pennsylvania) folio, which has been issued during the year, affords a striking example of the first-hand aid in oil and gas development to be derived from the careful delineation of geologic structure and its economic explanation. Not inferior in scientific value to the papers just cited, though primarily economic, are such reports as those by Messrs. Brooks and Prindle on the Mount McKinley region, Alaska, and by Messrs. Calkins and Emmons on the geology and ore deposits of the Philipsburg quadrangle, in Montana.

#### WORK IN LAND CLASSIFICATION.

An important and interesting effect upon the scientific work of the Survey has resulted from the work in land classification. The constantly increasing demand for both completeness and exactness of information regarding the mineral resources of the public lands under classification have developed methods and scope of view in this economic work that have exerted a marked influence on the folio work in other areas.

Thus, the training and methods developed in the course of the classification of the coal lands have brought about higher standards of refinement in stratigraphy, as well as in economic work, in other regions of the country. Another very notable illustration of scientific results springing from the study of economic problems is found in the administration of the Weeks Act. The intensive hydrometric

experimental studies carried on in order actually to show, in accordance with the terms of the law, the degree of protection afforded by forests to soil and water in certain areas proposed for purchase as national forests have resulted in empirical determinations and demonstrations of high scientific value as well as of tangible economic importance.

#### WORK ON OIL AND GAS.

The principles governing the origin and mode of occurrence of petroleum and natural gas are as yet but fragmentarily grasped. Every oil field examined in detail contributes its data for use in the eventual interpretation of the problems, and each pool is studied with keen alertness for the discovery of some key which may aid in the coordination of the data, which sometimes, according to the region and conditions, seem, on account of our lack of knowledge, even to be in conflict. The observations made by the Survey geologists in the oil and gas fields of California and Kentucky promise to further the solution of some of the problems, and by pointing out the relations of oil and gas occurrence to the geologic structure of the regions examined they have rendered important scientific as well as economic aid in oil and gas development; but the basic principles controlling the widely varied modes of occurrence and accounting for the differences in kinds of the oils in widely separated regions are possibly still far from view.

#### THEORETIC WORK BY SURVEY GEOLOGISTS.

On account of the more conservative and dignified character of the official publications of the Survey and the care taken to confine their substance to matters of demonstrated fact, they do not offer to the geologists the forum for free discussion of scientific theories and problems that is afforded to those periodicals and serial publications of scientific societies which are especially devoted to matters of strictly professional interest and which are more widely distributed among scientists. For this reason many of the scientific results of the Survey's operations are first published in these journals. Examples of papers of high rank contributed in this way are numerous. Without implying relative merit among these, mention as typical may be made of the paper by Mr. Campbell, "Historical review of theories advanced by American geologists to account for the origin and accumulation of oil," published in *Economic Geology*, vol. 6, No. 4, and that by Mr. Ulrich, entitled "Revision of the Paleozoic systems," printed in the *Bulletin of the Geological Society of America*, vol. 22, No. 3. Besides contributing to the programs of other scientific societies in Washington, the members of the Survey maintain for the discussion of purely geologic topics three profes-

sional societies, including the Geological Society of Washington, before which Mr. Campbell's paper, just cited, was presented as a presidential address. Meetings of some one of these societies or of their sections average two a week for the winter and by far the greater number of the papers read are offered by members of the Survey.

#### EDUCATIONAL WORK OF THE SURVEY.

Closely connected with the scientific work of the Survey is its educational function, which has not on the whole received the attention that so importantly useful a work deserves. The Survey has, however, in cooperation with several State surveys, participated in the preparation of a number of educational bulletins that have, in accordance with the agreements, been submitted to the respective States for publication. As distinctly educational in their scope, though far from elementary, should be named the valuable paper by Mr. Willis entitled, "Index to the stratigraphy of North America," published as a professional paper in explanation of the new geologic map of the continent, and the paper by Messrs. Tarr and Martin describing the earthquake phenomena in the region of Yakutat Bay, Alaska.

A notable contribution to the study of physiography was the Survey's Professional Paper 60, "The interpretation of topographic maps," by R. D. Salisbury and W. W. Atwood, consisting chiefly of reprints of parts of the Survey's maps and of brief suggestions as to the origin and history of the features shown on them. For many years the topographic maps made by the Survey have been regularly used in the courses of instruction in geography and physiography in most of the universities and colleges and to some extent in the secondary schools. It is very gratifying to note that the maps prepared in accordance with the present high standard, and more fully adapted to such use, are coming to the attention of teachers in the graded and country schools. Teachers of schools located in the quadrangles surveyed in recent years find the corresponding topographic sheets a most practical and invaluable aid to their efficiency and success in teaching elementary geography.

#### LAND-CLASSIFICATION POLICY.

Formal action was taken on May 1, 1912, giving the land-classification board the rank of an independent branch within the Geological Survey. This recognition of the increasing importance of this phase of the work of the bureau is in line with other developments in the present public-land policy, which has highest utilization as its purpose. The present epoch in public-land legislation and administration may be said to date from 1888, when Congress made special provision for an irrigation survey and authorized the with-

drawal or reservation, pending further legislation, of the reservoir sites and irrigable lands designated as a result of special investigation by the Geological Survey. This legislation was simply the forerunner of the reclamation act of 1902, which is most notable as providing a practical means of insuring that the irrigable lands thus classified shall be put to their highest use, through a Federal agency, the Reclamation Service. In a somewhat similar way the act of June 4, 1897, marked the beginning of a national-forest policy of administration on a scale that later necessitated the organization of another technical corps, the Forest Service. The legislation of 1897 is interesting in this connection as providing specifically for examination and survey of forest areas by the United States Geological Survey for purposes of land classification.

During the last decade, however, "classification of the public lands," the first of the statutory functions of the Geological Survey, has come to take a large share of its activities. The field data accumulated as the result of three decades of geologic and topographic surveys, of stream measurement, and of detailed investigation of every mineral resource now contribute to putting into practice this business policy. In practice land classification means simply the determination of highest use. To encourage development and at the same time to enforce wise utilization by preventing partial or wasteful use is to protect the public interest. With the different values of the land made known by adequate examination, the highest use can be determined and, in so far as the statutes are in accord with economic law, the highest use can be assumed.

The scientific classification of the Nation's lands is now an integral part of the public-land administration. The field work of the geologist and the engineer is made to contribute to a business policy in the management of the Nation's real estate along three distinct lines. Quantitative knowledge of the land and its resources is now made a preliminary, first, to disposition of lands under the various settlement and development laws; second, to reservation of lands from present acquisition pending the enactment of adequate legislation; and third, to valuation of lands where the statute provides for disposition at prices expressing known value. For each of these phases a statement of the past year's work will best serve the purpose of illustration.

The determination of the character and the highest use of land for the purpose of disposing of it under the appropriate law includes its classification as mineral or nonmineral and as irrigable or non-irrigable. Upon the questions of fact as to mineral character depends the passage of title from the Government under the agricultural or mineral laws and the applicability of certain railroad non-mineral land grants. The total area classified for these purposes in



the fiscal year ended June 30, 1912, was one and a half million acres. The questions involving water supply on the public lands bear directly upon the administration of the statutes encouraging irrigation and dry farming, namely, the Carey Act and the desert-land and enlarged-homestead laws, as well as various right-of-way statutes. Upon the determination by field engineers of the quantity of water actually available for reclaiming the arid lands must wait the development of the remnant of agricultural lands in the public domain. Hydrographic classification of lands to serve this practical end aggregated last year more than 2,000,000 acres.

The second phase of activity in land classification is one that provides for future rather than present disposition of the public domain. The withdrawal act of June 25, 1910, looks forward to better utilization in the future and opens up the question of amendment of present laws by specific provision for reservation from immediate disposal of oil and gas and phosphate lands and of power and reservoir sites. Under the authority of the statute the Geological Survey during the fiscal year 1912 recommended the executive withdrawal of more than one and one-third million acres of oil reserves and almost one and one-fifth million acres of phosphate reserves, based on geologic data; of more than one-third million acres of water-power sites and 60,000 acres of irrigation-reservoir sites, based on hydrographic and topographic surveys; and of 86,000 acres of public water reserves essential to the control of public grazing lands. The areas of the outstanding withdrawals are approximately four and three-fourths million acres of public lands chiefly valuable for oil and gas, three and one-third million acres of phosphate lands, more than one and four-fifths million acres of lands essential to water-power development, nearly one hundred thousand acres primarily valuable for irrigation storage, and 86,000 acres of lands including springs or other watering places, unrestricted access to which, by the public, is essential in connection with the free use of the public range. The areas thus described as withdrawn, however, include tracts of privately owned land, which are in reality unaffected by the orders of withdrawal, although located in the larger legal subdivisions enumerated in those orders.

The third and most direct application of science to national stewardship is the valuation of the public coal lands. The coal-land law of 1873 is essentially a sales rather than a settlement law and provides for a minimum selling price. Since 1907 coal lands have been sold at appraised prices fixed by the Geological Survey on the basis of geologic field examination and chemical and physical analyses, valuation data of the latter kind being obtained from the Bureau of Mines, which is charged by its organic law with the analyzing and testing of coals and lignites.

**WORK OF THE YEAR.****GENERAL INCREASE.**

Although the appropriations made directly for the Geological Survey showed an increase of only \$30,480 over those of 1911, there was a notable increase in the amount of work done by the field service. The funds available through cooperation with other Federal bureaus and with the States amounted in 1912 to 27 per cent of the direct appropriations and showed an increase over cooperative funds of the preceding year of 42 per cent. This increase in the field work involved a large increase in the work of the Washington office, to which was added the greatly increased service rendered the Secretary's Office, the General Land Office, and the Office of Indian Affairs in connection with public-land administration.

**PUBLICATIONS.**

The work done by the Survey finds public expression chiefly through its printed reports and maps, which are published in editions adapted to meet the demand. During the fiscal year ended June 30, 1912, the number of reports printed (437,501) corresponded very closely to the number distributed (437,637). The reports are sent out only on application.

The publications of the year are listed below.

**THIRTY-SECOND ANNUAL REPORT** of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1911. 1911. 151 pages, 2 plates.

A report on special features of the Survey's work, brief abstracts of publications of the year, and a summary of the work by branches and divisions, with maps showing the progress of topography and geologic surveys.

**MONOGRAPH LII.** The geology of the Lake Superior region, by C. R. Van Hise and C. K. Leith. 1911. 641 pages, 49 plates, 76 text figures. Price \$2.50.

An exhaustive treatise, representing the first attempt to give a connected account of the geology of this region as a whole, with special reference to the iron and copper bearing formations for which it is famous. Attention is directed primarily to general features of correlation of the formations, to the geologic history of the region, and to the origin of the iron and copper ores. The volume contains accurate maps of all the producing districts, a general geologic map of the region, diagrams, and halftone reproductions of photographs of minerals.

**PROFESSIONAL PAPER 69.** The earthquakes at Yakutat Bay, Alaska, in September, 1899, by R. S. Tarr and Lawrence Martin, with a preface by G. K. Gilbert. 1912. 135 pages, 33 plates, 5 text figures.

A detailed discussion of the earthquakes occurring at Yakutat Bay in 1899 and the phenomena accompanying them. As this is the first seismic disturbance that has been proved to be the direct cause of a great advance and complete breaking up of glaciers, the report will be of interest and value to scientists investigating variations in the movement of glaciers. Evidence is also



presented that the earthquakes caused notable local movements, upward or downward, of the surface of the earth. The Yakutat shock of September 10, 1899, is classed among the "world-shaking" shocks—that is, those which affect seismographs all around the earth. The book is profusely illustrated with halftone plates and diagrams of the region after the earthquakes and with seismograms of the shocks taken in different parts of the world.

**PROFESSIONAL PAPER 70.** The Mount McKinley region, Alaska, by A. H. Brooks, with descriptions of the igneous rocks and of the Bonfield and Kantishna districts, by L. M. Prindle. 1911. 234 pages, 18 plates, 30 text figures.

A detailed account of an exploratory journey from the Pacific seaboard through the Alaska Range along the northwest base of Mount McKinley to Tanana and Yukon rivers, with full descriptions of the stratigraphy, structure, and geologic history of the whole Mount McKinley province and a concise statement of the present knowledge of the mineral wealth of the region. Summarizes all available information concerning climate, vegetation, agricultural lands, and game. Illustrated by topographic and geologic maps, geologic sections, and halftone views.

**PROFESSIONAL PAPER 73.** The Tertiary gravels of the Sierra Nevada of California, by Waldemar Lindgren. 1911. 226 pages, 28 plates, 16 text figures.

This report traces a part of the history of the Sierra Nevada, the great range which, for 300 miles, divides the central valleys of California from the deserts of the Great Basin. It presents an account of the Tertiary formations of the range and deals especially with the origin and distribution of the gold-bearing gravels which made these mountains one of the treasure houses of the world. Contains detailed descriptions of the area by quadrangles. The illustrations include geologic maps and sections and halftone plates showing features of hydraulic mining.

**PROFESSIONAL PAPER 75.** Geology and ore deposits of the Breckenridge district, Colorado, by F. L. Ransome. 1911. 187 pages, 33 plates, 29 text figures.

This report gives the results of an investigation of one of the most important mining districts of Colorado, including descriptive and economic geology, topographic and geologic maps, and numerous halftone plates and text figures showing geologic features. The minerals of the district are listed and their characteristics noted. The important mines are described in detail, and general conclusions are drawn as to the economic future of the mining industry in this region.

**BULLETIN 448.** Geology and mineral resources of the Nizina district, Alaska, by F. H. Moffit and S. R. Capps. 1911. 111 pages, 12 plates, 11 text figures.

A detailed account of investigations in this part of the Chitina copper belt, including descriptive, historical, and economic geology, topographic and geologic maps, and halftone plates and text figures showing geologic features. The most important result of these investigations is the fact that the copper-ore bodies appear to occur chiefly along a system of cross fractures which are at approximately right angles to the greenstone-limestone contact. These fractures occur along well-defined faults, at least one of which has been traced for a long distance. This may apply to the entire Chitina district and is worthy of consideration by the prospector.

**BULLETIN 450.** Mineral resources of the Llano-Burnet region, Texas, with an account of the pre-Cambrian geology, by Sidney Paige. 1911. 103 pages, 5 plates, 22 text figures.

Deals chiefly with the geologic relations of the pre-Cambrian rocks in this region and with the associated iron ores. Contains three geologic maps.

**BULLETIN 451.** Reconnaissance of the ore deposits in northern Yuma County, Arizona, by Howland Bancroft. 1911. 130 pages, 8 plates, 21 text figures.

A description of the deposits and a brief geologic sketch of their formation, with views of the mining properties.

**BULLETIN 454.** Coal, oil, and gas of the Foxburg quadrangle, Pennsylvania, by E. W. Shaw and M. J. Munn. 1911. 85 pages, 10 plates, 15 text figures.

A discussion of the stratigraphy, structure, and mineral resources of the quadrangle, which is in the central part of Pennsylvania, about 75 miles north of Pittsburgh. Contains general and detailed descriptions of the coals, coal analyses, and descriptions by townships of the oil and gas pools. Illustrated by well and coal sections and geologic maps.

**BULLETIN 455.** Copper deposits of the Appalachian States, by W. H. Weed. 1911. 166 pages, 6 plates, 32 text figures.

A report on the occurrence of copper in the Appalachian region and in the Atlantic coast States, including a discussion of the types of copper deposits. All important mines are described in detail, by States. The report is illustrated by text figures showing the workings of many of the mines, by plates showing specimens of ores, and by diagrams indicating geologic structure.

**BULLETIN 456.** Oil and gas fields of the Carnegie quadrangle, Pennsylvania, by M. J. Munn. 1911. 99 pages, 5 plates, 2 text figures.

A report on the stratigraphy and structure of the region, with special reference to the origin of the oil and gas and the general position of the pools in each producing sand. The oil and gas fields are described in detail by townships. Sketch maps and sections of wells in the region illustrate the report.

**BULLETIN 458.** Results of spirit leveling in Arkansas, Louisiana, and Mississippi, 1896 to 1909, inclusive—R. B. Marshall, chief geographer. 1911. 79 pages, 1 plate.

**BULLETIN 464.** Results of spirit leveling in New Mexico, 1902 to 1909, inclusive—R. B. Marshall, chief geographer. 1911. 53 pages, 1 plate.

Reports on precise and primary leveling in the States indicated in the titles, showing the altitude above sea level of a great number of places. In Louisiana and Mississippi the work during part of the time was done in cooperation with the respective States. Each of these bulletins contains a halftone illustration, showing designs for bench marks used by the United States Geological Survey.

**BULLETIN 466.** Retracement of the boundary line between Idaho and Washington from the junction of Snake and Clearwater rivers northward to the international boundary—R. B. Marshall, chief geographer. 1911. 39 pages, 7 plates, 1 text figure.

A report on the resurvey of part of the Idaho-Washington boundary line, including an account of the original survey and descriptions of operations and mileposts. Contains a lithographed map of the boundary line.

**BULLETIN 467.** Geology and mineral resources of parts of the Alaska Peninsula, by W. W. Atwood. 1911. 137 pages, 14 plates, 18 text figures.

Results of an investigation of the Chignik, Herendeen Bay, and Unga coal fields, including some information, collected incidentally, in regard to the general geology and mineral resources of the entire peninsula. Accompanied by accurate detailed maps of the surveyed fields and halftone plates showing geographic and geologic features of the region.

**BULLETIN 468.** Results of spirit leveling in Texas, 1896 to 1910, inclusive—R. B. Marshall, chief geographer. 1911. 133 pages, 1 plate.

**BULLETIN 469.** Results of spirit leveling in North Dakota, 1897 to 1910, inclusive—R. B. Marshall, chief geographer. 1911. 23 pages, 1 plate.

Reports on precise and primary leveling in the States indicated in the titles, showing the altitude above sea level of a great number of places. Each of these bulletins contains a halftone illustration showing designs for bench marks used by the United States Geological Survey.

**BULLETIN 470.** Contributions to economic geology (short papers and preliminary reports), 1910, Part I, Metals and nonmetals except fuels—C. W. Hayes and Waldemar Lindgren, geologists in charge. 1911. 558 pages, 17 plates, 64 text figures.

Composed of 28 brief reports on investigations of mineral deposits, except fuels, made in the United States in 1910. These papers are only such as have a direct economic bearing, all topics of purely scientific interest being excluded. They have been grouped according to the subjects treated, and each group has been issued as an advance chapter as soon as it was ready. A complete list of the papers included in the report follows:

The auriferous gravels of the Trinity River basin, Cal., by J. S. Diller.

The economic geology of Carson camp, Hinsdale County, Colo., by E. S. Larsen.

Geology and mineralization of the upper St. Joe River basin, Idaho, by J. T. Pardee.

Gold-bearing ground moraine in northwestern Montana, by F. C. Schrader.  
Geologic relation of ore deposits in the Elkhorn Mountains, Mont., by R. W. Stone.

Notes on the economic geology of the Ramsey, Talapoosa, and White Horse mining districts, in Lyon and Washoe counties, Nev., by J. M. Hill.

The ore deposits near Pinos Altos, N. Mex., by Sidney Paige.

Survey publications on gold and silver.

Metalliferous ore deposits near the Burro Mountains, Grant County, N. Mex., by Sidney Paige.

Preliminary report on the mineral deposits of Ducktown, Tenn., by W. H. Emmons and F. B. Laney.

Survey publications on copper.

Notes on lead and copper deposits in the Bear River Range, Idaho and Utah, by R. W. Richards.

Lead and zinc deposits in the Metaline mining district, northwestern Washington, by Howland Bancroft.

Survey publications on lead and zinc.

The arsenic deposits at Brinton, Va., by F. L. Hess.

Survey publications on antimony, chromium, monazite, nickel, platinum, quicksilver, tin, tungsten, uranium, vanadium, etc.

Iron ores in the Montevallo-Columbiana region, Alabama, by Charles Butts.

Survey publications on iron and manganese ores.

Survey publications on aluminum ores—bauxite, cryolite, etc.

Survey publications on asphalt.

Variegated marble southeast of Calera, Shelby County, Ala., by Charles Butts.

Supplementary notes on the commercial granites of Massachusetts, by T. N. Dale.

Survey publications on building stone and road metal.

Survey publications on cement and concrete materials.

Clay near Calhan, El Paso County, Colo., by G. B. Richardson.

Clay resources of the Murphysboro quadrangle, Illinois, by E. W. Shaw.

Notes on some clays from Texas, by Alexander Deussen.

Survey publications on clays, fuller's earth, etc.

Gypsum deposits in Eagle County, Colo., by E. F. Burchard.

Survey publications on gypsum and plasters.

Survey publications on lime and magnesite.

Survey publications on glass sand and glass-making materials.

Survey publications on abrasive materials.

Preliminary report on a portion of the Idaho phosphate reserve, by R. W. Richards and G. R. Mansfield.

Rock phosphate near Melrose, Mont., by H. S. Gale.

A reconnaissance of the phosphate deposits in western Wyoming, by Eliot Blackwelder.

Survey publications on phosphates and other mineral fertilizers.

Paint shales of Pennsylvania, by B. L. Miller.

Survey publications on mineral paints.

Survey publications on salines, including salt, borax, and soda.

Sulphur deposits near Soda Springs, Idaho, by R. W. Richards and J. H. Bridges.

Survey publications on sulphur and pyrite.

The types, modes of occurrence, and important deposits of asbestos in the United States, by J. S. Diller.

Dolomite for flux in the vicinity of Montevallo, Shelby County, Ala., by Charles Butts.

Graphite near Dillon, Mont., by A. N. Winchell.

Fluorspar near Deming, N. Mex., by N. H. Darton and E. F. Burchard.

Survey publications on miscellaneous nonmetallic products—asbestos, barite, feldspar, fluorspar, graphite, mica, quartz, etc.

**BULLETIN 471.** Contributions to economic geology (short papers and preliminary reports), 1910, Part II, Mineral fuels; advance chapters as follows:

Bulletin 471-A. Petroleum and natural gas. 1911. 132 pages, 10 plates, 2 text figures. Contains the following papers:

The Campton oil pool, Kentucky, by M. J. Munn.

Oil and gas development in Knox County, Ky., by M. J. Munn.

The Fayette gas field, Alabama, by M. J. Munn.

The Powder River oil field, Wyoming, by C. H. Wegemann.

Geology of the San Juan oil field, Utah, by E. G. Woodruff.

Marsh gas along Grand River near Moab, Utah, by E. G. Woodruff.

Notes on the geology and possible oil resources of the south end of the San Joaquin Valley, Cal., by Robert Anderson.

Bulletin 471-B. Coal on Dan River, N. C., by R. W. Stone. 1912. 35 pages, 1 plate, 4 text figures.

Report on an examination of all coal exposures in the Dan River district, leading to the conclusion that no commercially valuable coal beds exist there.

Bulletin 471-C. Lignite in the Fort Berthold Indian Reservation, N. Dak., north of Missouri River, by M. A. Pishel. 1912. 19 pages, 2 plates.

A brief report on the lignite beds of this district, estimated to contain 1,819,953,682 tons of available fuel.

Bulletin 471-E. Coal fields in Montana. 1912. 66 pages, 3 plates. Contains the following papers:

The southern extension of the Milk River coal field, Chouteau County, Mont., by L. J. Pepperberg.

The Livingston and Trail Creek coal fields, Park, Gallatin, and Sweet grass counties, Mont., by W. R. Calvert.

The Electric coal field, Park County, Mont., by W. R. Calvert.

BULLETIN 472. Results of spirit leveling in South Dakota, 1896 to 1910, inclusive—R. B. Marshall, chief geographer. 1911. 54 pages, 1 plate.

BULLETIN 473. Results of spirit leveling in Kansas and Nebraska, 1896 to 1909, inclusive—R. B. Marshall, chief geographer. 1911. 42 pages, 1 plate.

Reports on precise and primary leveling in the States indicated in the titles, showing the altitude above sea level of a great number of places. Each of these bulletins contains a halftone illustration showing designs for bench marks used by the United States Geological Survey.

BULLETIN 474. Coals of the State of Washington, by E. E. Smith. 1911. 206 pages, 8 plates.

A discussion of the character and quality of the coals of the State, giving analyses, methods of sampling, and detailed descriptions, by counties, of the mines and coals. A map of a portion of western Washington, showing the distribution of coal mines and prospects, and halftone plates illustrate the bulletin.

BULLETIN 475. The diffusion of crude petroleum through fuller's earth, with notes on its geologic significance, by J. E. Gilpin and O. E. Bransky. 1911. 50 pages, 7 text figures.

An account of experiments in which crude Illinois petroleum was allowed to diffuse upward through fuller's earth. These experiments were similar to those discussed in Bulletin 365 and confirmed the results of the earlier work. One object was to obtain further light as to the variations among the oils of this country.

BULLETIN 476. Results of spirit leveling in Ohio, 1909 and 1910—R. B. Marshall, chief geographer. 1911. 79 pages, 1 plate.

A report on precise and primary leveling in Ohio, showing the altitude above sea level of a great number of places. The work was done in cooperation with the State. The bulletin contains a halftone illustration showing designs for bench marks used by the United States Geological Survey.

BULLETIN 477. Results of spirit leveling in West Virginia, 1909 and 1910—R. B. Marshall, chief geographer. 1911. 54 pages, 1 plate.

A supplement to Bulletin 399, showing the altitude above mean sea level of more than 900 places determined by precise leveling of the Geological Survey and the Coast and Geodetic Survey and by primary leveling of the Geological Survey. The work was done in cooperation with the State. The *bulletin contains a halftone illustration showing Geological Survey bench marks.*

**BULLETIN 478.** Geology and ore deposits near Lake City, Colo., by J. D. Irving and Howland Bancroft. 1911. 128 pages, 8 plates, 33 text figures.

Discusses the geology of the San Juan Mountains and the Lake City district and gives a brief history of their mineral industry and detailed descriptions of their ore deposits and mines. The illustrations include topographic and geologic maps and diagrams of the veins and workings.

**BULLETIN 479.** The geochemical interpretation of water analyses, by Chase Palmer. 1911. 31 pages, 1 text figure.

An exposition of the principle that natural water may be definitely characterized if the salts dissolved in it are recognized not as a load, but as a chemical system of balanced values. The relation of silica to primary alkalinity and the persistence of silica in river waters are among the topics considered.

**BULLETIN 480.** Mineral resources of Alaska—report on progress of investigations in 1910, by A. H. Brooks and others. 1911. 333 pages, 13 plates, 19 text figures.

This bulletin includes the following papers:

Administrative report, by A. H. Brooks.

Report on progress of surveys of public lands in Alaska during 1910, by A. H. Brooks.

The mining industry in 1910, by A. H. Brooks.

Geologic features of Alaskan metalliferous lodes, by A. H. Brooks.

Mining in southeastern Alaska, by Adolph Knopf.

The Eagle River region, by Adolph Knopf.

The upper Susitna and Chistochina districts, by F. H. Moffit.

Preliminary report on a detailed survey of part of the Matanuska coal fields, by G. C. Martin.

A reconnaissance of the Willow Creek gold region, by F. J. Katz.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth and G. L. Parker.

Mineral resources of the Bonnifield region, by S. R. Capps.

Gold placer mining developments in the Innoko-Iditarod region, by A. G. Maddren.

The Shungnak region, Kobuk Valley, by P. S. Smith and H. M. Eakin.

The Squirrel River placers, by P. S. Smith.

**BULLETIN 481.** Results of spirit leveling in California, 1907 to 1910, inclusive—R. B. Marshall, chief geographer. 1911. 115 pages, 1 plate.

**BULLETIN 482.** Results of spirit leveling in Montana, 1896 to 1910, inclusive—R. B. Marshall, chief geographer. 1911. 154 pages, 1 plate.

Reports on precise and primary leveling in California and Montana, respectively, showing the altitude above sea level of a great number of places in each State. The work in Sacramento, Salinas, and San Joaquin valleys, Cal., was done in cooperation with the State. Each bulletin contains a halftone illustration showing designs for bench marks used by the United States Geological Survey.

**BULLETIN 483.** Economic geology of Richmond, Va., and vicinity, by N. H. Darton. 1911. 47 pages, 10 plates, 1 text figure.

Describes the rocks of Richmond and vicinity, with special reference to the high-grade granite and brick clays. Accompanied by a map showing the economic geology of the district and halftone plates illustrating the working of the quarries and clay deposits.



**BULLETIN 484.** The granites of Connecticut, by T. N. Dale and H. E. Gregory. 1911. 137 pages, 7 plates, 12 text figures.

Treats of Connecticut granites both scientifically and economically, classifying them, giving statistics of production, and describing the quarries and their product in detail. The illustrations consist of halftone plates showing some of the uses made of the granites and maps and sections of the quarries.

**BULLETIN 485.** A geologic reconnaissance of the Iliamna region, Alaska, by G. C. Martin and F. J. Katz. 1912. 136 pages, 9 plates, 20 text figures.

A sketch of the stratigraphic and structural geology of a recently surveyed district situated in southwestern Alaska, west of the southern half of Cook Inlet and north of the Alaska Peninsula. Special mention is made of the mode of occurrence of the copper lodes and auriferous quartz veins, and the few claims and prospects now in existence are briefly discussed. The report contains tables showing the sequence and character of rocks in different parts of the region and the correlation of formations in western and southwestern Alaska, topographic and geologic maps, and structure sections.

**BULLETIN 486.** Results of spirit leveling in Colorado, 1896 to 1909, inclusive—R. B. Marshall, chief geographer. 1911. 107 pages, 1 plate.

**BULLETIN 487.** Results of spirit leveling in Idaho, 1896 to 1909, inclusive—R. B. Marshall, chief geographer. 1911. 46 pages, 1 plate.

**BULLETIN 488.** Results of spirit leveling in Nevada, 1897 to 1909, inclusive—R. B. Marshall, chief geographer. 1911. 28 pages, 1 plate.

**BULLETIN 489.** Results of spirit leveling in Utah, 1897 to 1910, inclusive—R. B. Marshall, chief geographer. 1911. 38 pages, 1 plate.

Reports on precise and primary leveling in the States indicated in the titles, showing the altitude above sea level of a great number of places. Each of these bulletins contains a halftone illustration showing designs for bench marks used by the United States Geological Survey.

**BULLETIN 490.** Mineralogical notes—series 1, by W. T. Schaller. 1911. 109 pages, 14 text figures.

Results of researches in mineralogy in the chemical laboratory of the United States Geological Survey from 1905 to 1909. Describes many new minerals and contains text figures showing their crystal forms.

**BULLETIN 491.** The data of geochemistry (second edition), by F. W. Clarke. 1911. 782 pages.

A manual of geologic chemistry, including chapters on the nature, distribution, and relative abundance of the chemical elements, the composition of the atmosphere and of volcanic gases and sublimates, the mineral content of surface and underground waters, the nature of saline residues, the molten magma of the earth's interior, the rock-forming minerals, the composition of igneous, sedimentary, and metamorphic rocks, rock metamorphism and decomposition, metallic ores, natural hydrocarbons, coal, lignite, and peat.

**BULLETIN 492.** The gabbros and associated rocks at Preston, Conn., by G. F. Loughlin. 1912. 158 pages, 14 plates, 18 text figures.

A detailed description of the areal and structural geology in the vicinity of Preston, with especial reference to the petrography of the gabbros and other igneous rocks. The illustrations consist of photomicrographs of the rocks and maps showing the location of outcrops and the geology of the district.



**BULLETIN 493.** Results of spirit leveling in Illinois, 1909 and 1910—R. B. Marshall, chief geographer. 1911. 115 pages, 1 plate.

A report on precise and primary leveling, showing the altitude above sea level of more than 1,300 places. Contains a halftone illustration showing designs for bench marks used by the United States Geological Survey.

**BULLETIN 494.** The New Madrid earthquake, by M. L. Fuller. 1912. 119 pages, 10 plates, 18 text figures.

A systematic discussion of the phenomena accompanying the shocks of the earthquake at New Madrid, Mo., in 1811-12, which may be regarded as a type, exhibiting in unusual detail the geologic effects of great disturbances upon unconsolidated deposits. The illustrations include maps, diagrams, and halftone plates.

**BULLETIN 495.** Bibliography of North American geology for 1910, with subject index, by J. M. Nickles. 1911. 179 pages.

A list of papers published in 1910 on North American geology, arranged alphabetically by names of authors, an index of subjects or materials, and lists showing chemical analyses reported and minerals, rocks, and formations described.

**BULLETIN 496.** Results of triangulation and primary traverse for the years 1909 and 1910—R. B. Marshall, chief geographer. 1912. 392 pages, 2 plates.

Gives the results of triangulation and primary traverse in the United States for the years 1909 and 1910, listing 428 triangulation stations and 6,903 primary traverse stations, nearly all on United States standard datum. Includes a map showing the condition of astronomic location and primary control to January 1, 1911, and a halftone plate showing Geological Survey station marks.

**BULLETIN 497.** A reconnaissance of the Jarbidge, Contact, and Elk Mountain mining districts, Elko County, Nevada, by F. C. Schrader. 1912. 162 pages, 26 plates, 3 text figures.

A sketch of the geology of this promising mining region, surveyed for the first time in the summer of 1910, with descriptions of mines and prospects and a discussion of the mineral deposits. The illustrations include geologic reconnaissance maps, maps showing surveyed claims, and halftone plates of mineral specimens.

**BULLETIN 499.** Coal near the Black Hills, Wyoming-South Dakota, by R. W. Stone. 1912. 66 pages, 7 plates, 8 text figures.

Gives the results of two field examinations of all known coal exposures near the Black Hills and includes all information previously published by the United States Geological Survey on this subject. The geology of the district is briefly discussed and the coal localities are treated separately and in detail. The illustrations include sketch maps of mines and prospects and sections of coal beds.

**BULLETIN 500.** Geology and coal fields of the lower Matanuska Valley, Alaska, by G. C. Martin and F. J. Katz. 1912. 98 pages, 19 plates, 12 text figures.

Describes the geology of an important coal-bearing region of Alaska, surveyed in detail in the summer of 1910, discusses the character and accessibility of its coal beds, and gives sections of many of these beds. Topographic and geologic maps and halftone plates showing geologic features make up the illustrations.

**BULLETIN 504.** The Sitka mining district, Alaska, by Adolph Knopf. 1911. 32 pages, 1 plate, 4 text figures.

A sketch of the geology of the Sitka mining district, comprising Chichagof, Baranof, Kruzof, and a few smaller islands, with especial reference to the mineral resources of the west coast. After 10 years' stagnation in the mining industry of this district, interest has been revived by the discovery and prosperous development of high-grade gold ore at Klag Bay, 50 miles north of Sitka. A geologic reconnaissance map of the Sitka and Juneau mining districts accompanies the report.

**BULLETIN 505.** Mining laws of Australia and New Zealand, by A. C. Veatch, with a preface by Walter L. Fisher, Secretary of the Interior. 1911. 180 pages.

A summary of the underlying principles, development, and practical workings of the mining laws of Australia, Tasmania, and New Zealand, investigated by Mr. Veatch in 1907-8 by order of the President. Reprinted from report of the joint committee of Congress to investigate the Department of the Interior and the Bureau of Forestry.

**BULLETIN 506.** Geology and mineral resources of the Peoria quadrangle, Illinois, by J. A. Udden. 1912. 103 pages, 9 plates, 16 text figures.

A study of the geology of the Peoria quadrangle with especial reference to its coal deposits. In this quadrangle are situated the manufacturing cities of Peoria and Pekin, whose growth has been enhanced by their proximity to workable coal beds. The bulletin includes a chapter on the water resources of the district and is illustrated by geologic maps, halftone views of coal mines, and sections and diagrams of coal exposures.

**BULLETIN 507.** The mining districts of the western United States, by J. M. Hill, with a geologic introduction by Waldemar Lindgren. 1912. 309 pages, 16 plates, 1 text figure.

A catalogue, by States and counties, of the mining districts of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Texas (western part), Utah, Washington, and Wyoming, with a section on the local geology of their ore deposits. The book contains a map of each State showing the location of its mining districts and an alphabetic index of all the districts.

**BULLETIN 509.** Mineralogical notes—series 2, by W. T. Schaller. 1912. 115 pages, 1 plate, 5 text figures.

A continuation of Bulletin 490, giving results of researches in mineralogy in the chemical laboratory of the United States Geological Survey from January, 1910, to June, 1911. Many new and rare minerals are discussed.

**BULLETIN 511.** Alunite, a newly discovered deposit near Marysvale, Utah, by B. S. Butler and H. S. Gale. 1912. 64 pages, 3 plates.

An account of the discovery of alunite near Marysvale, Utah, and the development of the deposit as an important source of potash. The known occurrences of alunite both in the United States and elsewhere are mentioned and its commercial availability is discussed.

**BULLETIN 512.** Potash-bearing rocks of the Leucite Hills, Sweetwater County, Wyoming, by A. R. Schultz and Whitman Cross. 1912. 1 plate, 9 text figures.

Describes briefly the rocks in the Leucite Hills, Wyoming, and estimates the *amount* of leucite-bearing rock available and the approximate amount of

potash that these rocks may yield as soon as a process is discovered by which the potash can be dissociated from the rock cheaply enough for commercial use.

**BULLETIN 520.** Mineral resources of Alaska, 1911; advance chapters as follows:

Bulletin 520-B. Tin resources of Alaska, by F. L. Hess. 1912. 6 pages.

Bulletin 520-K. Geologic investigations along the Canada-Alaska boundary, by A. G. Maddren. 1912. 20 pages.

Bulletin 520-M. Notes on mining in Seward Peninsula, Alaska, by P. S. Smith. 1912. 8 pages.

**BULLETIN 530.** Contributions to economic geology (short papers and preliminary reports), 1911, Part I, Metals and nonmetals except fuels; advance chapters as follows:

Bulletin 530-A. The search for potash in the United States: A report of progress, by H. S. Gale. 1911. 27 pages, 1 plate, 1 text figure.

Bulletin 530-B. The occurrence of potash salts in the bitterns of the eastern United States, by W. C. Phalen. 1911. 18 pages.

These papers deal with experiments now in progress in the search for potash in the United States, with the purpose of developing a home industry and reducing the importation from Germany. Chapter A tells of experiments in well drilling in Nevada, and chapter B gives results of a systematic study of the brines, bitterns, and rock-salt deposits east of the Rocky Mountains. As yet potash in commercial quantities has not been discovered, but the information collected seems to warrant further investigation.

Bulletin 530-C. The Turquoise copper-mining district, Arizona, by F. L. Ransome. 1912. 12 pages, 2 text figures.

Bulletin 530-D. Notes on the gold lodes of the Carrville district, Trinity County, Cal., by D. F. MacDonald. 1912. 37 pages, 1 plate, 9 text figures.

Bulletin 530-F. Alunite in the San Cristobal quadrangle, Colo., by E. S. Larsen. 1912. 7 pages.

Bulletin 530-G. Gold and silver in Idaho. 1912. 23 pages, 1 plate, 1 text figure. Contains:

A preliminary account of the ore deposits of the Loon Creek district, Idaho, by J. B. Umpleby.

Geology of the St. Joe-Clearwater region, Idaho, by F. C. Calkins and E. L. Jones, jr.

Bulletin 530-I. Notes on the clays of Delaware, by G. C. Matson; Clay in the Portland region, Maine, by F. J. Katz. 1912. 24 pages, 1 text figure.

Bulletin 530-J. Notes on the Antelope district, Nevada, by F. C. Schrader. 1912. 14 pages, 1 plate, 1 text figure.

Bulletin 530-L. Graphite near Raton, N. Mex., by W. T. Lee; Mica in Idaho, New Mexico, and Colorado, by D. B. Sterrett. 1912. 22 pages, 3 text figures.

Bulletin 530-M. Notes on the northern La Sal Mountains, Grand County, Utah, by J. M. Hill. 1912. 22 pages, 1 text figure.

Bulletin 530-N. Gypsum in Utah and Virginia. 1912. 37 pages, 1 plate, 5 text figures. Contains:

Gypsum along the west flank of the San Rafael Swell, Utah, by C. T. Lupton.  
Geology of the salt and gypsum deposits of southwestern Virginia, by G. W. Stose.

Bulletin 530—O. Sulphur in Utah, Wyoming, and Colorado. 1912. 25 pages, 1 plate, 1 text figure. Contains:

A sulphur deposit in the San Rafael Canyon, Utah, by F. L. Hess.

Sulphur deposits of Sunlight Basin, Wyoming, by D. F. Hewett.

Two sulphur deposits in Mineral County, Colo., by E. S. Larsen and J. F. Hunter.

Bulletin 530—P. Zirconiferous sandstone near Ashland, Va., by T. L. Watson and F. L. Hess. 1912. 9 pages.

**WATER-SUPPLY PAPERS** 261, 266, 267, 268, 269, 271, 272. Parts of "Surface water supply of the United States, 1909," prepared under the direction of M. O. Leighton:

Part I. Water-Supply Paper 261. North Atlantic coast, by H. K. Barrows, C. C. Covert, and R. H. Bolster. 1911. 309 pages, 5 plates, 1 text figure.

Part VI. Water-Supply Paper 266. Missouri River basin, by W. A. Lamb, W. B. Freeman, and F. F. Henshaw. 1911. 291 pages, 5 plates, 1 text figure.

Part VII. Water-Supply Paper 267. Lower Mississippi basin, by W. B. Freeman and R. H. Bolster. 1911. 99 pages, 2 plates, 1 text figure.

Part VIII. Water-Supply Paper 268. Western Gulf of Mexico, by W. B. Freeman and R. H. Bolster. 1911. 107 pages, 6 plates.

Part IX. Water-Supply Paper 269. Colorado River basin, by W. B. Freeman and R. H. Bolster. 1911. 247 pages, 9 plates, 1 text figure.

Part XI. Water-Supply Paper 271. California, by W. B. Clapp and F. F. Henshaw. 1911. 256 pages, 6 plates, 1 text figure.

Part XII. Water-Supply Paper 272. North Pacific coast, by J. C. Stevens, E. C. La Rue, and F. F. Henshaw. 1911. 521 pages, 8 plates.

These reports contain descriptions of the drainage basins named and the results of stream measurements in them, namely, gage-height records, results of current-meter measurements, and daily and monthly discharges. Illustrations showing typical gaging stations, current meters, and rating curves accompany each book.

**WATER-SUPPLY PAPER** 273. Quality of the water supplies of Kansas, by H. N. Parker, with a preliminary report on stream pollution by mine waters in southeastern Kansas, by E. H. S. Bailey. 1911. 375 pages, 1 plate, 1 text figure.

Presents the results of an investigation, conducted in cooperation with the Kansas State Board of Health, to determine the quality of the water supplies of the State. Describes briefly the salient geologic features in order that their relation to the water supply may be understood and contains 190 tables giving analyses and assays of the different waters. The underground sources are discussed separately by counties and the surface streams by river basins.

**WATER-SUPPLY PAPER** 274. Some stream waters of the western United States, with chapters on sediment carried by the Rio Grande and the industrial application of water analyses, by Herman Stabler. 1911. 188 pages.

A report setting forth the results of a systematic study of the waters likely to be utilized on the Reclamation Service projects. This study was made in order to determine the influence of the salinity of the waters on the growth of vegetation and the effect of suspended matter in silting canals and reservoirs. Contains tables giving analyses, gage heights, rates of discharge, and relative amounts of substances in solution in the waters of different rivers.

**WATER-SUPPLY PAPER 275.** Geology and water resources of Estancia Valley, N. Mex., with notes on ground-water conditions in adjacent parts of central New Mexico, by O. E. Meinzer. 1911. 89 pages, 14 plates, 7 text figures.

Describes the physiography, geology, soils, and climate of this valley, which, although for a long time sparsely settled, has only recently become accessible by railroads. Gives special attention to the water of the valley, discussing its source and disposal, head, recovery, and quality, and the proper mode of irrigation. Illustrations showing geologic and hydrographic features accompany the report.

**WATER-SUPPLY PAPER 276.** Geology and underground waters of northeastern Texas, by C. H. Gordon. 1911. 78 pages, 2 plates, 6 text figures.

An account of the geology of the region, both descriptive and historical, with special reference to its effect on the character and distribution of underground waters. The geography, geology, and water resources are treated by counties. Sections of several deep wells are given.

**WATER-SUPPLY PAPER 277.** Ground waters in Juab, Millard, and Iron counties, Utah, by O. E. Meinzer. 1911. 158 pages, 5 plates, 13 text figures.

A report on the water resources of an important section of central Utah, including a discussion of rainfall, soil, vegetation, streams, and industrial development. The occurrence of ground water is described and its quality considered. Its availability for irrigation, culinary supplies, and boiler supplies are given special attention. Watering places on routes of travel in the vicinity of the Sevier Desert are listed, and the report concludes with detailed descriptions of the water resources of the region.

**WATER-SUPPLY PAPER 278.** Water resources of the Antelope Valley, California, by H. R. Johnson. 1911. 92 pages, 7 plates, 11 text figures.

Sketches the drainage, climate, and geologic features of the valley, with especial reference to the water-bearing rocks. Describes the water resources and their economic development in detail and gives tables of data concerning individual wells.

**WATER-SUPPLY PAPER 279.** Water resources of the Penobscot River basin, Maine, by H. K. Barrows and C. C. Babb. 1912. 285 pages, 19 plates, 5 text figures.

Compiled chiefly from the records, reports, and maps of the United States Geological Survey and from the results of surveys made in cooperation with the Maine State Survey Commission. The report includes all data on precipitation, stream flow, water storage, and water power that were available at the end of the calendar year 1909 and is accompanied by plans and profiles of the principal rivers, lakes, and ponds in the basin. It contains also a gazetteer of the water features in the Penobscot basin, by G. E. Schulz.

**WATER-SUPPLY PAPER 280.** Gaging stations maintained by the United States Geological Survey, 1888-1910, and Survey publications relating to water resources, compiled by B. D. Wood. 1912. 102 pages.

Includes a complete list of the Survey gaging stations on streams in the United States and a list of all reports on water resources published by the United States Geological Survey, arranged in the order of their publication.

**WATER-SUPPLY PAPERS 282, 285, 286, 287, 288.** Parts of "Surface water supply of the United States, 1910," prepared under the direction of M. O. Leighton:

Part II. Water-Supply Paper 282. South Atlantic coast and eastern Gulf of Mexico, by M. R. Hall and J. G. Mathers. 1912. 109 pages, 3 plates.

Part V. Water-Supply Paper 285. Hudson Bay and upper Mississippi River, by Robert Follansbee, A. H. Horton, and G. C. Stevens. 1912. 318 pages, 3 plates.

Part VI. Water-Supply Paper 286. Missouri River basin, by W. A. Lamb, W. B. Freeman, Raymond Richards, and R. C. Rice. 1911. 308 pages, 4 plates, 1 text figure.

Part VII. Water-Supply Paper 287. Lower Mississippi basin, by W. B. Freeman and J. G. Mathers. 1911. 91 pages, 2 plates.

Part VIII. Water-Supply Paper 288. Western Gulf of Mexico, by W. B. Freeman and J. G. Mathers. 1911. 149 pages, 3 plates, 1 text figure.

These reports contain descriptions of the drainage basins named and the results of stream measurements in them, namely, gage-height records, results of current-meter measurements, and dally and monthly discharges. Illustrations showing typical gaging stations, current meters, and rating curves accompany each book.

**WATER-SUPPLY PAPER 295.** Gazetteer of surface waters of California, Part I, Sacramento River basin, prepared under the direction of J. C. Hoyt by B. D. Wood. 1912. 97 pages.

The first of a series of reports on the surface waters of California, prepared by the United States Geological Survey under cooperative agreement with the State of California as represented by the State Conservation Commission and the State Board of Control (Water Powers). Every stream and gaging station in the Sacramento River basin is listed in this paper.

**MINERAL RESOURCES OF THE UNITED STATES, calendar year 1909.** Part I. Metals: 617 pages, 1 plate, 4 text figures. Part II. Nonmetals; 942 pages, 6 text figures.

**MINERAL RESOURCES OF THE UNITED STATES, calendar year 1910.** Part I. Metals; 796 pages, 1 plate, 9 text figures. Part II. Nonmetals, 1,005 pages, 17 plates, 10 text figures. 1911.

Statistics of production of mineral substances in the United States, including accounts of the chief features of mining progress and comparisons of past and present production and conditions. The report for 1909 is a consolidation of 53 advance chapters, that for 1910 of 51, each of which covers a single mining industry or group of allied industries.

**MINERAL RESOURCES OF THE UNITED STATES, calendar year 1911; advance chapters as follows:**

Iron-ore reserves of Michigan, by C. K. Leith. 1912. 18 pages, 1 text figure.

The production of talc and soapstone, by J. S. Diller. 1912. 9 pages.

The production of bauxite and aluminum, by W. C. Phalen. 1912. 19 pages, 1 text figure.

The production of asbestos, by J. S. Diller. 1912. 9 pages.

Potash salts, summary for 1911, by W. C. Phalen. 1912. 31 pages.

The production of graphite, by E. S. Bastin. 1912. 38 pages, 3 text figures.

The production of slate, by A. T. Coons. 1912. 19 pages.



The production of sand-lime brick. 1912. 5 pages.

The production of mica. by D. B. Sterrett. 1912. 9 pages.

The production of monazite and zircon, by D. B. Sterrett. 6 pages.

Sulphur, pyrite, and sulphuric acid, by W. C. Phalen, with notes on the manufacture of sulphuric acid from smelter fumes at Ducktown, Tenn., by F. B. Laney. 1912. 30 pages.

The production of phosphate rock, by F. B. Van Horn. 1912. 14 pages.

The production of fuller's earth, by Jefferson Middleton. 1912. 7 pages.

Statistics of the pottery industry in the United States, by Jefferson Middleton. 1912. 11 pages.

Quicksilver—production and resources, by H. D. McCaskey. 1912. 35 pages.

The production of asphalt, related bitumens, and bituminous rock, by D. T. Day. 1912. 21 pages.

The production of abrasive materials, by W. C. Phalen. 1912. 22 pages.

Gold, silver, copper, lead, and zinc in the Eastern States (mine production), by H. D. McCaskey. 1912. 18 pages.

The gypsum industry, by E. F. Burchard. 1912. 8 pages.

The production of chromic iron ore, by W. C. Phalen. 1912. 10 pages.

**GEOLOGIC FOLIO 178.** Description and maps of the Foxburg and Clarion quadrangles, comprising 450 square miles in western Pennsylvania, northeast of Pittsburgh, by E. W. Shaw, E. F. Lines, and M. J. Munn. 1911. 17 folio pages of text, 8 maps, 1 columnar-section sheet, 1 well-section sheet, 12 text figures. Published also in octavo form, 127 pages; maps in pocket.

**GEOLOGIC FOLIO 179.** Description and maps of the Pawpaw and Hancock quadrangles, comprising 460 square miles in eastern West Virginia, western Maryland, and southern Pennsylvania, by G. W. Stose and C. K. Swartz. 1912. 24 folio pages of text, 4 maps, 2 structure-section sheets, 1 columnar-section sheet, 20 halftone plates, 11 text figures, and a table of formation names and equivalents. Published also in octavo form, 176 pages; maps in pocket.

**GEOLOGIC FOLIO 180.** Description and maps of the Claysville quadrangle, comprising 228 square miles in Greene and Washington counties, Pennsylvania, by M. J. Munn. 1912. 14 folio pages of text, 4 maps, 1 columnar-section sheet, 1 well-section sheet, 10 text figures. Published also in octavo form, 98 pages; maps in pocket.

**GEOLOGIC FOLIO 181.** Description and maps of the Bismarck quadrangle, comprising 820 square miles in central North Dakota, by A. G. Leonard. 1912. 8 folio pages of text, 2 maps, 1 text figure. To be published also in octavo form.

**GEOLOGIC FOLIO 182.** Description and maps of the Choptank quadrangle, comprising 931.51 square miles in Anne Arundel, Kent, Queen Annes, Talbot, Caroline, and Dorchester counties, Maryland, by B. L. Miller. 1912. 8 folio pages of text, 2 maps, 3 text figures. To be published also in octavo form.

**GEOLOGIC FOLIO 183.** Description and maps of the Llano and Burnet quadrangles, comprising 2,050 square miles in Llano, Burnet, Mason, San Saba, Travis, and Williamson counties, Texas, by Sidney Paige. 1912. 16 folio pages of text, 4 maps, 2 structure-section sheets, 11 plates, 6 text figures. To be published also in octavo form.



## TOPOGRAPHIC MAPS as follows:

Beverly, Wash.	Keefers, Cal. <sup>2</sup>	Oxford, Ohio.
Biggs, Cal.	Kezar Falls, Maine-N. H.	Pineville, W. Va.
Blackfoot, Mont.	Knoxville, Iowa.	Pocahontas special, Va.-
Bridgeport, Cal.-Nev.	Kosmosdale, Ky.-Ind.	W. Va.
Brighton, Cal.	Lake, Wyo. <sup>1</sup>	Pounding Mill, W. Va. <sup>2</sup>
Browns Valley, Cal.	Lake Providence, La.	Prospect, Ky.-Md. <sup>2</sup>
Butte City, Cal.	Landlow, Cal.	Quarryville, Pa.
Caldwell, Ohio.	Laurelville, Ohio.	Randsburg, Cal. <sup>1</sup>
Cambridge, Ohio.	Leavenworth and vicinity.	Ray, N. Dak.
Canal Dover, Ohio.	Kans.-Mo.	Ray and vicinity, Ariz.
Canton, N. Y.	Lincolnton, N. C.	Rochester, N. Y. <sup>1</sup>
Canyon, Wyo. <sup>1</sup>	Livermore, Me.	Rochester special, N. Y. <sup>1</sup>
Cataldo, Idaho-Mont.	Loramie, Ohio.	Rolla, Mo.
Clear Creek, Cal.	McKeever, N. Y.	Sacramento Valley, Cal.
Colorado River surveys, Cal.-	McKittrick, Cal.	Salinas Valley, Cal., sheet
Nev. (4 sheets). <sup>2</sup>	Madison, W. Va.	No. 1. <sup>2</sup>
Copper Mountain and vicinity, Alaska.	Mason, Mich.	Sallisaw, Okla. <sup>4</sup>
Creede and vicinity, Colo.	Meridian, Cal.	Sanborn Slough, Cal.
Cumberland, Ohio.	Miami copper belt, Arizona.	Sansbois, Okla. <sup>4</sup>
Cut Bank, Mont.	Milledgeville, Ga.	Shoshone, Wyo. <sup>1</sup>
De Beque oil field, Mont.	Mills, Cal.	Singer Creek, Cal.
Delhi, N.Y.	Minnesota (State).	Spencerville, Ohio.
Delphos, Ohio.	Mississippi (State).	Summerfield, Ohio.
Dry Creek, Cal.	Montpeller, Idaho-Wyo.-	Sutter, Cal.
Elizabeth, Ill.	Utah.	Taylorsville-La Grange, Ky. <sup>2</sup>
Franklin, Pa.	Montrose, Colo.	Thibedean Lake, Mont.
Gallatin, Wyo. <sup>1</sup>	Mount Goddard, Cal.	Tisdale Weir, Cal.
Gilbert, W. Va.-Va.-Ky.	Mount Guyot, Tenn.-N. C. <sup>4</sup>	Uhrichsville, Ohio.
Gilsizer Slough, Cal.	Mount Jackson, Colo.	United States base map, 18
Glacier National Park, Mont.	Mullens, W. Va.	by 28 inches. <sup>1</sup>
Gridley, Cal.	Muskingum County, Ohio.	United States contour map.
Grimes, Cal.	Naugutuck, W. Va. <sup>2</sup>	18 by 28 inches. <sup>1</sup>
Hamburg, Pa.	Nelson, Cal.	United States relief map, 18
Hammond, N. Y.	New Athens, Ill.	by 28 inches. <sup>1</sup>
Hartwick, N. Y.	New Berlin, N. Y.	Vermont (State).
Honcut, Cal.	Newhard, Cal.	Welch, W. Va.
Illinois (State).	North America, 28 by 38	Willamette Valley, Oreg.,
Ivanpah, Cal.-Nev.	inches.	sheet No. 4. <sup>2</sup>
Jefferson County, Ky.	Ontario Beach, N. Y. <sup>1</sup>	Yellowstone National Park,
Kasaan Peninsula, Alaska.	Oroville, Cal. <sup>2</sup>	Wyo.-Mont.-Idaho. <sup>2</sup>
	Ostrom, Cal.	Yuba City, Cal.

**GEOLOGIC MAP OF NORTH AMERICA**, compiled by the United States Geological Survey in cooperation with the Geological Survey of Canada and the Instituto Geológico de México under the supervision of Bailey Willis and George W. Stose. Scale 1:5,000,000, or 80 miles to the inch. Printed in four parts, which together make a wall map 60 by 77 inches. Shows 42 geologic divisions.

**CONVENTIONAL SIGNS:** A sheet (20 by 30 inches) showing conventional signs adopted by the United States Geographic Board and recommended for use on Government maps.

<sup>1</sup> New edition.

<sup>2</sup> Preliminary photolithograph.

<sup>3</sup> Preliminary edition showing part of quadrangle.

<sup>4</sup> Reengraved.

<sup>5</sup> Revised and enlarged.

### FIELD WORK BY THE DIRECTOR.

During the season of 1911 the Director had field conferences with or visited parties in New Hampshire, Utah, Nevada, and Washington. In Utah the principal field conference was held with the chief geologist and G. F. Loughlin in connection with the revision of the survey of the Tintic mining district made in 1897. In Nevada an examination of a potash locality was made in company with H. S. Gale and A. H. Brooks. A large portion of the Director's attention was given, both in the field and in the office, to the administration of the examination by the Geological Survey of proposed national forest reservations. Three inspection visits were made to the field parties working in New Hampshire, one August 2-3, 1911, one November 12-16, 1911, and one May 24-26, 1912. Another trip was made November 10-11, 1911, for inspection of areas in Tennessee. A trip was also made to Virginia April 27-29, 1912, in company with the members of the National Forest Reservation Commission. The Director also attended meetings of the American Institute of Mining Engineers, the Geological Society of America, and the American Mining Congress, presenting at the mining congress a paper on "What the West needs in coal-land legislation."

### CHANGES IN ORGANIZATION.

The only important formal change in the organization during the year was that of making the land-classification board equal in rank with the field branches. As contrasted with the three field branches of the Geological Survey, the land-classification board may be designated as the office of field records and intradepartmental correspondence on all matters relating to the classification of the public lands and the administration of the public domain. The board thus receives records and makes available all data valuable for purposes of land classification that have been or may be collected by the field service of the Geological Survey.

On October 15, 1911, Dr. C. W. Hayes, who had been a member of the Survey for 23 years and served as chief geologist since 1902, resigned in order to become vice president and manager of the Compañía Mexicana de Petróleo "El Águila." The vacancy thus created was filled by the appointment of Waldemar Lindgren, who had been a geologist of the Survey for 27 years.

### GEOLOGIC BRANCH.

#### ADMINISTRATION.

The geologic branch embraces four divisions—(1) geology, Waldemar Lindgren in charge; (2) Alaskan mineral resources, A. H. Brooks in charge; (3) mineral resources, E. W. Parker in charge; and (4) chemical and physical research, G. F. Becker in charge.

The chief geologist has general supervision of the work of the geologic branch. C. W. Hayes resigned as chief geologist on October 15, 1911, and on November 3 Waldemar Lindgren was appointed to fill this position. The divisions composing the branch cooperate effectively in their several lines of work. Members of one division are employed in the work of another whenever it seems desirable. The statistical reports of the division of mineral resources are for the most part prepared by geologists, who are detailed from the division of geology for a portion of the year.

The land-classification board was also included in the geologic branch until May 1, 1912, when it was made a separate branch.

The administrative duties of the chief geologist prevent him from carrying on systematic field work. His work outside of the office consists chiefly of the planning of future examinations and of field conferences for determining questions of dispute.

#### PUBLICATIONS.

The publications of the year prepared in the geologic branch included 6 geologic folios, 2 professional papers, 24 bulletins, and the annual volumes on mineral resources. Besides these publications 101 papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies. Such publications are ordinarily restatements of results in a more technical form and are usually prepared by members of the Survey without compensation.

The areal extent of geologic maps published by the Survey to date is shown on Plate I.

#### DIVISION OF GEOLOGY.

##### ORGANIZATION.

The scientific force at the beginning of the year consisted of 62 geologists, 57 assistant geologists, and 38 junior geologists. During the year there were 8 resignations and 1 appointment, the total being 150 at the end of the year. Of the total number, 75 were continuously employed, 34 carried on the per diem roll gave only a part of their time to Survey work, and 41 were not employed during the year. In addition to the regular force, 16 field assistants were employed for a part of the year.

The work of the division was organized under a number of sections, as follows:

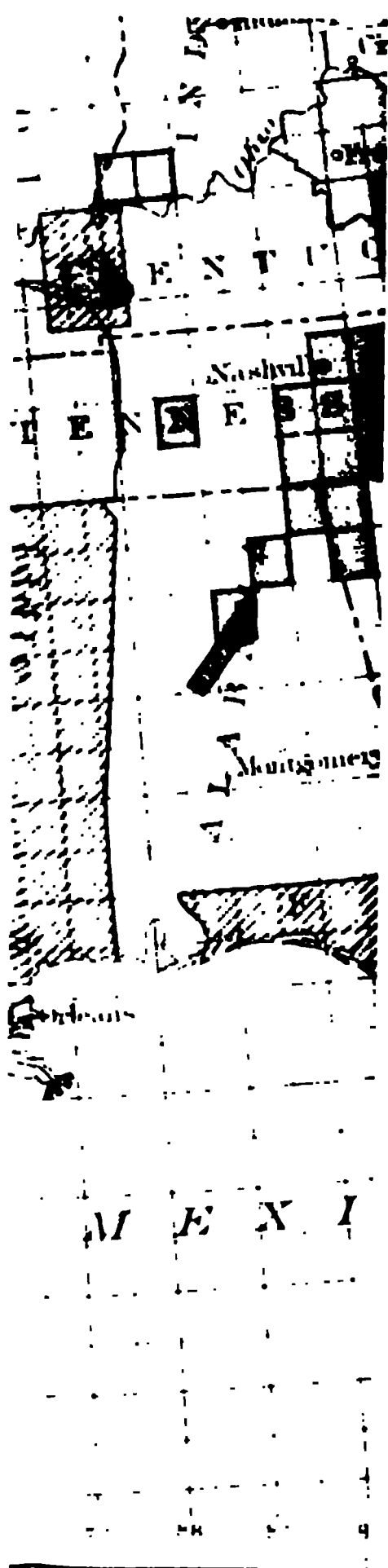
Areal and structural geology, Arthur Keith in charge.

Paleontology and stratigraphic geology, T. W. Stanton in charge.

Economic geology, metalliferous ores, Waldemar Lindgren in charge.

Economic geology, nonmetalliferous minerals, F. B. Van Horn in charge.

Economic geology, fuels, M. R. Campbell in charge.





The section chiefs have direct supervision, both in the field and in the office, of the work in their sections and are directly responsible for maintaining efficiency and a high scientific standard.

The following changes were ordered in the arrangement of sections in the division of geology and paleontology, effective July 1, 1912:

1. Section of eastern areal and structural geology (east of the one hundredth meridian), Arthur Keith in charge. Subsection: Investigation of the geology of the Coastal Plain, T. W. Vaughan in charge.
2. Section of western areal and structural geology (west of the one hundredth meridian), F. L. Ransome in charge. Subsection: Investigations and work relating to petrography. E. S. Larsen in charge.
3. Section of glacial geology, W. C. Alden in charge.
4. Section of paleontology and stratigraphic geology, T. W. Stanton in charge.
5. Section of economic geology, metalliferous deposits, Waldemar Lindgren in charge.
6. Section of economic geology, nonmetalliferous deposits, H. S. Gale in charge.
7. Section of economic geology, eastern mineral fuels (east of the one hundredth meridian), David White in charge.
8. Section of economic geology, western mineral fuels (west of the one hundredth meridian), M. R. Campbell in charge.

#### ALLOTMENTS.

The total appropriations for geologic surveys for the fiscal year 1911-12 were:

Geologic surveys.....	\$300,000
Statutory salaries.....	15,700
Search for potash deposits (part of appropriation for chemistry and physics).....	20,000
	<hr/>
	335,700

The allotments of the appropriations were as follows:

Section of areal and structural geology.....	\$62,980
Subsection of geology of Coastal Plain.....	12,200
Section of paleontology.....	23,570
Section of economic geology of metalliferous ores.....	39,500
Section of economic geology of nonmetalliferous minerals, including potash.....	34,300
Section of economic geology of western fuels.....	51,946
Section of economy geology of eastern fuels.....	15,600
Work of land-classification board.....	25,000
Supervision, administration, salaries of clerical, technical, and skilled-labor force.....	70,604
	<hr/>
	335,700

The above table shows that \$240,096 was expended directly for geologic work, including the search for potash. Of this amount \$141,746, or 59 per cent, was expended west of the one hundredth meridian and \$98,350 east of that line.

The cooperative funds expended during the fiscal year 1911-12 were as follows:

General Land Office, for coal-land classification.....	\$35, 000
General Land Office, classification of Northern Pacific land grant.....	13, 238
Indian Office, classification of land in Indian reservations, Montana, Washington, and Oklahoma.....	8, 709
Department of Justice.....	1, 763
Cooperation with States and official organizations.....	4, 850
	<hr/> 63, 560

The money allotted by the General Land Office, amounting to \$48,238, was expended west of the one hundredth meridian. The first item of \$35,000 was expended by the section of western fuels, for classification of coal land.

In the cooperative agreements for geologic work with the States of Alabama, Illinois, and Missouri it is provided that the funds contributed by the States should be handled by the local organization. In the cooperative agreements with Oklahoma, Maine, and Tennessee the cooperative funds contributed by the States have been expended by the United States Geological Survey.

During the fiscal year geologic work was done in 40 States, listed below:

Alabama.	Massachusetts.	Oklahoma.
Arizona.	Michigan.	Oregon.
Arkansas.	Minnesota.	Pennsylvania.
California.	Mississippi.	South Carolina.
Colorado.	Missouri.	South Dakota.
Delaware.	Montana.	Tennessee.
Georgia.	Nevada.	Texas.
Idaho.	New Hampshire.	Utah.
Illinois.	New Jersey.	Vermont.
Kansas.	New Mexico.	Virginia.
Kentucky.	New York.	Washington.
Louisiana.	North Carolina.	Wyoming.
Maine.	North Dakota.	
Maryland.	Ohio.	

#### SECTION OF AREAL AND STRUCTURAL GEOLOGY.

##### WORK OF CHIEF OF SECTION.

The work of Arthur Keith has been for the most part of an administrative character, consisting mainly of conferences with other geologists and supervision and inspection of results in areal and structural geology, both in the field and in the office. Much of this work has been done in connection with the geologic folios. The attainment of harmony and unity in the folios requires frequent conferences on all matters treated in them.



A great deal of Mr. Keith's time has been devoted to service on committees, including those on geologic names, illustrations, plans, and maps. The largest single portion of this committee service has consisted of work done on geologic names under his chairmanship until March 15, when he resigned on account of press of other work.

Maps of the following quadrangles already submitted for folio publication were inspected in the field: Boston and Marlboro, Mass.; Brandon and Castleton, Vt.; East Columbus and West Columbus, Ohio; and Colorado Springs, Colo.

Field conferences were held and inspection trips made by Mr. Keith with the geologists who were mapping the areal geology in the following quadrangles: Portland, Maine; Worcester and Marlboro, Mass.; Ducktown, Tenn.; Gaffney, S. C.; Cohutta, Ga.; Columbus, Ohio; Vinita, Nowata, and Claremore, Okla.; Deadwood and Rapid, S. Dak.; Minneapolis and St. Paul, Minn.; Castle Rock and Colorado Springs, Colo.

Mr. Keith, with the assistance of D. B. Sterrett, completed the review of the areal geology of the Cowee quadrangle, N. C., which will soon be offered for publication in a folio. He completed, also with Mr. Sterrett, the joint study of the areal geology of the Gaffney quadrangle.

Special investigations were continued by Mr. Keith into the faulted structure of the north end of the Taconic Mountains in the Brandon and Castleton quadrangles, Vt. A paper on this faulted area was presented at the meeting of the Geological Society of America. He also continued his study of the structure and stratigraphic succession of the rocks of the Vermont Valley and Green Mountains in the vicinity of Brandon, Vt.

Further studies were made in the peculiar metamorphic rocks around Ducktown, Tenn., and Murphy, N. C. A brief special study was made, in company with E. M. Kindle, of the Devonian section and of the boundary between the Ordovician and Silurian strata along Cumberland Mountain in northeastern Tennessee and Virginia.

A reconnaissance was made by Mr. Keith in the Talbotton quadrangle, Ga., and Walhalla quadrangle, S. C.

The greater portion of Mr. Keith's office time was occupied with investigations and discussions in connection with geologic folios. The descriptive texts of nine folios in course of preparation were critically read by Mr. Keith and the structural geology and areal mapping of these folios and many others were especially considered. In the editorial work he was assisted during the year by Laurence La Forge.

Numerous papers presented for publication by the Survey or in various periodicals were critically read, and the geologic maps for Survey reports were examined.

## WORK IN NEW ENGLAND STATES.

The description of the geology of the Eastport quadrangle, Maine, has been completed by E. S. Bastin for folio publication in cooperation with the State of Maine.

F. J. Katz began the areal and economic survey of the Portland and Casco Bay quadrangles, Maine, for publication in a folio in cooperation with the State Water Storage Commission. This work was somewhat more than half done at the end of the field season. A preliminary map has been prepared by Mr. Katz and the field material has been worked up to date. From May 23 to the end of the fiscal year Mr. Katz was occupied in an examination of areas in North Carolina which are proposed for forest reserves under the Weeks Act and in the preparation of reports thereon. This work lies mainly in the Cranberry, Morganton, and Mount Mitchell quadrangles.

C. H. Clapp has offered for publication as a bulletin a report on the igneous rocks of Essex County, Mass. The material for this report was obtained by Mr. Clapp at his own expense.

Progress has been made in the description of the Boston and Boston Bay quadrangles, Mass., for the Boston folio by Laurence La Forge.

Prof. B. K. Emerson continued his field work in the Monadnock and Peterboro quadrangles, N. H., in extension of his work in central Massachusetts. He also revised portions of the areal geology of the Marlboro and Worcester quadrangles, Mass. The descriptive texts for the Worcester-Marlboro folio and the Webster-Blackstone folio have been prepared jointly with W. C. Alden and the folios submitted for publication.

Prof. Emerson has nearly completed the descriptive text and maps for the Sheffield-Sandisfield folio, covering two quadrangles in western Massachusetts, for publication under joint authorship with Prof. Joseph Barrell and Prof. T. Nelson Dale.

Prof. Barrell has completed the maps and description of the eastern half of the Sheffield quadrangle.

Prof. Emerson has also made progress on work on the maps and text for the folio on the Pittsfield and Becket quadrangles in western Massachusetts, of which he and Prof. T. Nelson Dale are joint authors.

A preliminary report has been submitted by Prof. Emerson for publication as a bulletin on the geology of Massachusetts and Rhode Island. He has also submitted for publication as a bulletin a mineral lexicon of Worcester County, Mass.

W. C. Alden revised his descriptions of the Pleistocene geology of central Massachusetts for the folios covering the Worcester, Marl-

boro, Webster, Blackstone, Brookfield, Barre, Belchertown, and Palmer quadrangles.

Prof. T. Nelson Dale visited the marble districts of southeastern Vermont during July and August. The description of these has been prepared by him for publication in a bulletin. He also completed the revision of his manuscript for a bulletin on the commercial marbles of western Vermont (Bulletin 521). Prof. Dale made microscopic examinations of the roofing slates from Colorado, Georgia, California, and Lancaster County, Pa., for a report for the division of mineral resources. During June he visited the slate regions of Georgia, Tennessee, Virginia, Pennsylvania, and New Jersey to obtain material for a revised edition of Bulletin 275, "Slate deposits and slate industry of the United States," which is now out of print.

WORK IN NORTHERN APPALACHIAN REGION.

The manuscript for the folio on the Niagara region, N. Y., has been submitted by E. M. Kindle and F. B. Taylor. The Paleozoic formations have been described by Mr. Kindle and the Pleistocene by Mr. Taylor.

Prof. W. S. Bayley held a field conference in the Highlands of New Jersey during September with Dr. H. B. Kümmel, State geologist of New Jersey. During the winter Prof. Bayley completed the maps and descriptions of the pre-Cambrian rocks in the Easton and Delaware Water Gap quadrangles in New Jersey and Pennsylvania, thus completing for folio publication a discussion of the pre-Cambrian geology of the New Jersey Highlands. The preparation of the descriptions of the Paleozoic and Pleistocene formations in these quadrangles has been begun by Dr. Kümmel.

The maps and descriptions of the Bellefonte quadrangle, Pa., for folio publication have been submitted by Prof. E. S. Moore.

The geologic maps of the Coatesville and West Chester quadrangles, Pa., were revised by Prof. Florence Bascom and the mapping and study of the gneisses in the Boyerton quadrangle, Pa., was begun. Prof. Bascom has completed the description of the volcanic rocks of South Mountain for the Fairfield-Gettysburg folio.

Dr. C. K. Swartz is making a detailed study of the Carboniferous rocks in the Frostburg and Flintstone quadrangles, Md., for the Maryland Geological Survey and will revise the descriptions of those rocks for the Frostburg-Flintstone folio.

The areal mapping and study of the Coastal Plain in the Elkton and Wilmington quadrangles, Del., have been continued by Prof. B. L. Miller, assisted by M. I. Goldman. This work is being done in cooperation with the Maryland Geological Survey. Progress has been made in the preparation of the folio manuscript for these quadrangles.

Dr. W. B. Clark, State geologist of Maryland, has carried on work on the Upper Cretaceous of Maryland with E. W. Berry and M. I. Goldman, on the Tertiary of Virginia and North Carolina with Dr. Julia A. Gardner, and on the Lower Cretaceous with E. W. Berry and Arthur Bibbins. Office work has been carried on and substantial progress made for all these projects.

#### WORK IN SOUTHERN APPALACHIAN REGION.

Work in the Abingdon quadrangle, Va., was continued by G. W. Stose and the northern half was nearly completed. A report on the salt and gypsum deposits in the area has been submitted for publication by Mr. Stose (in Bulletin 530).

Work in the Kings Mountain region of North and South Carolina was continued by D. B. Sterrett, who did a small amount of revision in the Kings Mountain quadrangle, practically completed the areal survey of the Gaffney quadrangle, S. C., and mapped about one-fourth of the Lincolnton quadrangle, N. C.

A small amount of revision of the areal geology of the Cowee quadrangle, N. C., was completed in June by Mr. Keith and Mr. Sterrett. The last three weeks in June were devoted by Mr. Sterrett to an examination of areas for proposed forest reserves under the Weeks Act in the Pisgah and Cowee quadrangles, N. C., and to the preparation of a report thereon.

#### WORK IN CENTRAL STATES EAST OF THE NINETY-SEVENTH MERIDIAN.

The field work on the Pleistocene deposits of the East and West Cincinnati quadrangles, Ohio, was completed by Prof. N. M. Fenneman for folio publication. This included some work in areas adjoining on the north. The areal geologic map of the Paleozoic formations for these quadrangles has been completed by E. O. Ulrich and the preparation of the descriptive text has been begun. The folio covering the area will be published under the joint authorship of Mr. Ulrich and Prof. Fenneman.

The manuscript maps and descriptions for the Columbus folio, covering the East and West Columbus, Dublin, and Westerville quadrangles, Ohio, have been transmitted for publication by Dr. J. A. Bownocker, State geologist. The descriptions were prepared by Dr. Bownocker, Prof. C. R. Stauffer, and Prof. G. D. Hubbard. This folio is to be a cooperative publication by the Federal and State geological surveys and the material has been obtained mainly at the expense of the Ohio Survey. Prof. Stauffer has described the Paleozoic formations, Prof. Hubbard the Pleistocene formations and the geography, and Dr. Bownocker the economic geology.

The manuscript maps and descriptions for the Cleveland folio, *covering the* Cleveland, Euclid, and Berea quadrangles, Ohio, have

been transmitted by Dr. H. B. Cushing for publication. Dr. Cushing has prepared the descriptions of the Paleozoic geology, Dr. Frank Carney those of the Pleistocene formations, and Dr. F. R. Van Horn those of the economic geology.

Prof. W. H. Sherzer has completed the field work for the folio on the Detroit quadrangle, Mich. He has finished the areal geologic maps and has made considerable progress with the descriptions of the area. This work has been done in cooperation with the State Geological Survey.

The monograph on the Pleistocene of Indiana and Michigan has been revised and transmitted for publication by Frank B. Taylor and Frank Leverett.

The examination and mapping of the Pleistocene formations of northern and northeastern Minnesota have been continued by Frank Leverett, assisted by E. R. Preston.

Field conferences were held by Mr. Leverett on questions of Pleistocene geology with Prof. F. W. Sardeson in the Minneapolis-St. Paul area; with Prof. Samuel Weidman in northeastern Wisconsin; and with Prof. W. H. Sherzer in the Detroit area, Mich.

A bulletin by Mr. Leverett on the Pleistocene deposits and soils of the Northern Peninsula of Michigan was published by the State Geological Survey in cooperation with the United States Geological Survey. Mr. Leverett has also completed for publication by the State Survey a map of the Pleistocene deposits and soils of the Southern Peninsula of Michigan.

The collection of statistics and the gathering of information on the Lake Superior iron districts was continued under the direction of Pres. Charles R. Van Hise.

The examination and mapping of the Minneapolis, St. Paul, Anoka, and White Bear quadrangles, Minn., was completed by Prof. F. W. Sardeson, who has submitted for folio publication the maps and descriptions of those areas.

The areal mapping of the De Queen quadrangle, Ark., was continued by Prof. A. H. Purdue, State geologist, assisted by H. D. Miser, as far as the topographic base was done. A small area near Hot Springs, Ark., was reexamined by Prof. Purdue, the work on this quadrangle for folio publication being thus completed.

A reconnaissance section was run northwest from the Caddo Gap quadrangle to Arkansas River by Prof. Purdue and Mr. Miser. Mr. Miser, jointly with E. O. Ulrich, made a special review of certain Paleozoic formations in the Harrison and Eureka quadrangles, Ark. This work was extended into the Yellville quadrangle, Ark., so that the field work in those quadrangles is now completed. Progress has been made by Prof. Purdue in writing the descriptive text for the Caddo Gap folio, but he has been delayed because of his appointment as *State geologist of Tennessee*.

## WORK IN THE PUBLIC-LAND STATES.

*Central States west of the ninety-seventh meridian.*—The areal and economic survey of the Vinita quadrangle, Okla., was completed by Dr. D. W. Ohern. This work was done in cooperation with the State Survey of Oklahoma for folio publication. The office work on the maps and oil-well records is nearly completed, and progress has been made on the descriptions for the folio. Office work has been continued on the folio for the Nowata quadrangle, Okla., by Dr. Ohern and the manuscript will soon be submitted for publication. Office work is being done on a bulletin on the oil and gas resources of northeastern Oklahoma under the joint authorship of Dr. Ohern and Carl D. Smith.

The areal and economic survey of the Claremore quadrangle, Okla., was completed by Carl D. Smith, assisted by Robert H. Wood. The manuscript maps and descriptions for this quadrangle are now almost ready to be submitted for folio publication. This work has been done in cooperation with the State Survey of Oklahoma.

J. A. Taff has continued his preparation of the McAlester folio as fast as his professional duties permitted since his resignation from the Survey. It is expected that the manuscript will soon be submitted for publication.

C. E. Siebenthal continued his investigations of the zinc and lead deposits of northeastern Oklahoma and southwestern Missouri. The results of these studies will be incorporated in the Wyandotte folio, on which progress is being made.

N. H. Darton has completed for folio publication the description of the Cambrian and later formations in the Rapid and Deadwood quadrangles, S. Dak. A revision of the areal geology of the Spearfish quadrangle, S. Dak., was begun by Sidney Paige, and most of the area of the quadrangle was covered. The results of this work will be published as a special map in the Rapid-Deadwood folio.

*Rocky Mountain region.*—Work was carried on by M. R. Campbell, assisted by J. R. Hoats, on the survey of the Chief Mountain, Browning, and Midvale quadrangles, Mont., for folio publication. This area includes the larger part of the Glacier National Park. In association with Mr. Campbell, W. C. Alden, assisted by J. E. Thomas, conducted the work on the Pleistocene and the glacial features of the region. T. W. Stanton, paleontologist, was also for some time associated with Mr. Campbell in this work. Brief outlines of the results of this work have been presented by Mr. Campbell and Mr. Alden before the geological societies.

The survey of the Castle Rock quadrangle, Colo., was undertaken for a geologic folio by G. B. Richardson. The maps and descriptions for this folio have been completed and submitted for publication. Mr. Richardson also completed for outside publication a



report on the Monument Creek group in Colorado and a report on the structure of the foothills of the Front Range in Colorado.

In the Colorado Springs quadrangle, Colo., a small amount of revision was done by Prof. G. I. Finlay during and after a field conference with Mr. Keith in September.

The descriptive text for the folio on the Apishapa quadrangle, Colo., was completed by G. W. Stose and is now in press.

The survey of the San Juan Mountains in Colorado has been continued by Whitman Cross, assisted by E. S. Larsen, jr., and also during the field season by J. F. Hunter. The survey of the San Cristobal quadrangle, Colo., was completed for folio publication. The eastern half of the Uncompahgre quadrangle, Colo., was examined in a reconnaissance manner preliminary to preparation of a folio.

Office work has been carried on by Messrs. Cross and Larsen in preparation of the maps and descriptions for the San Cristobal folio, which will probably be submitted at an early date. Mr. Cross, with Mr. Larsen, has prepared for publication a paper on the unconformity at the base of the La Plata sandstone in Colorado. A bulletin on the potash-bearing rocks of the Leucite Hills, Wyo., has been prepared by Mr. Cross and A. R. Schultz and published as Bulletin 512.

The petrographic descriptions of the igneous rocks of the Apishapa quadrangle, Colo., have been completed by Mr. Cross for the Apishapa folio. Work upon a monographic discussion of the Hawaiian lavas has also been continued but is not yet completed. Mr. Cross served also as chairman of the committee to prepare definitions of sedimentary rock names.

A survey of the areal geology of Creede, Colo., and vicinity was made by E. S. Larsen, jr., in conjunction with W. H. Emmons, to complete the report on that mining district for publication as a professional paper.

Work was continued by Prof. W. W. Atwood, assisted by Kirtley F. Mather, on the Quaternary geology of the San Juan region, Colo. This work was carried on in association with that of Mr. Cross and the two parties were immediately associated in the field. The eastern half of the San Cristobal quadrangle was studied in detail, together with considerable adjoining territory to the south and east. In addition to the Quaternary mapping, Prof. Atwood is carrying out a systematic study of the physiographic development of the San Juan Mountains, aiming to connect the history of the mountains with that of the adjoining plateaus. He also did a small amount of work in the northern and eastern parts of the Montrose quadrangle, worked up the field data in the office, and put them into form for folio publication.



In connection with the investigation of underground water for the Indian Office, Prof. H. E. Gregory made a geologic reconnaissance of the Moki Buttes, Choiskai and Lukachukai mountains, and the Seven Lakes oil field, all on the Navajo and Moki reservations in Arizona and New Mexico. A geologic map and descriptions to accompany it are in preparation for the Navajo Reservation.

The descriptions for the geologic folio on the Silver City quadrangle, N. Mex., have been completed by Sidney Paige and submitted for publication. Mr. Paige also completed a small amount of revision of the folio text for the Llano and Burnet quadrangles, Tex., and the folio has been published.

A small amount of revision was done by N. H. Darton in the Deming quadrangle, N. Mex., and he has completed and submitted the maps and descriptions for the Deming folio.

Work has been continued by Prof. C. F. Tolman, jr., on the areal and economic survey of the Tucson quadrangle, Ariz., for folio publication. The field work for this folio is completed and the maps and descriptions will soon be submitted for publication.

*Work on the Pacific coast.*—The survey of the Klamath Mountains in northern California and Oregon has been continued by J. S. Diller. Mr. Diller made a detailed geologic reconnaissance of the Galice-Kerby region, lying west of the Riddles and Grants Pass quadrangles, Oreg., and has prepared a map of the area.

A report on the mineral resources of southwestern Oregon was prepared by Mr. Diller.

Mr. Diller also revised and prepared new illustrations for his description of Crater Lake, Oreg., and this has just been republished by the Interior Department. The Geological Survey is occasionally called upon for exhibits of its work and results and in the preparation of these exhibits Mr. Diller has had much to do.

The preparation of the folio on the Ventura quadrangle, Cal., has been continued by Dr. Ralph Arnold. Only a small amount of his time since his resignation could be devoted to this work, but the folio is now practically completed.

#### SUBSECTION OF GEOLOGY OF ATLANTIC AND GULF COASTAL PLAIN.

*Work of chief of subsection.*—T. Wayland Vaughan continued the supervision of Coastal Plain investigations. His field work consisted of an inspection tour in Louisiana, Texas, and Mississippi, where field parties were located. In order to obtain more information on the geology of the Canal Zone, for the purpose of correlating the geologic formations of the Gulf Coastal Plain with those of that region and procuring a basis for the intercorrelation of the geologic formations on the Atlantic and Pacific coasts of the United States, Mr. Vaughan spent one month, in October and November, in the

**Canal Zone.** The chairman of the Canal Commission, Col. George W. Goethals, and the Commission geologist, Mr. D. F. MacDonald, furnished Mr. Vaughan every possible facility for the prosecution of his investigation of the area. Arrangements have been made with specialists for the study of the collections procured. Mr. Vaughan also spent one month, in April and May, 1912, in the Bahamas, under the auspices of the Carnegie Institution of Washington. The object of this expedition was the extension of the studies of the geology and geologic processes of southern Florida to the Bahamas. Especial attention was given to the geology and the marine bottom deposits of the islands, and to the corals and coral reefs of Andros Island. Additional field work, mostly in June, was devoted to a continuation of his studies of the geology and geologic processes of southern Florida. Mr. Vaughan has almost completed his examination of the Florida keys, having visited nearly every one of the main line of keys. He has made substantial progress in his examination of the Florida coral reefs and his investigation of the corals of the region. The field expenses of these investigations in southern Florida are borne by the Carnegie Institution of Washington.

In the office Mr. Vaughan supervised the administrative work connected with the Coastal Plain investigations, read manuscripts and proofs of reports, studied collections of fossils (especially corals), and prepared summary statements of some of his investigations. He made progress in his researches on the correlation of the geologic formations of the Coastal Plain and resumed work on his monograph on the later Tertiary corals of the United States and the fossils of the West Indies and Central America.

The field work connected with the geologic survey of the Coastal Plain area is now completed as planned, except that for Cape Cod, the islands south of Massachusetts and Rhode Island, the delta of Mississippi River, a part of Mississippi, and the Rio Grande region of Texas.

During the fiscal year the following reports have been published or transmitted for publication:

The physiography and geology of the Coastal Plain province of Virginia, by William Bullock Clark and Benjamin LeRoy Miller, with chapters on the Lower Cretaceous, by Edward W. Berry, and the economic geology, by Thomas Leonard Watson. Cooperative report, published as Bulletin 4 of the Virginia Geological Survey.

Preliminary report on the geology of the Coastal Plain of Georgia, by Otto Veatch and Lloyd William Stephenson. Cooperative report, published as Bulletin 26 of the Georgia Geological Survey.

The New Madrid earthquake, by M. L. Fuller: Bull. U. S. Geol. Survey No. 494.

Notes on some clays from Texas, by Alexander Deussen: Bull. U. S. Geol. Survey No. 470-G.

Notes on the clays of Delaware, by George C. Matson: Bull. U. S. Geol. Survey No. 530-I.

A paper by E. W. Berry on the Upper Cretaceous and Eocene floras of South Carolina and Georgia was transmitted for publication as a professional paper.

A manuscript on the underground water resources of the Coastal Plain of Virginia, by Samuel Sanford, was transmitted to the State geologist for publication by the Virginia Geological Survey.

A report on the geology and underground waters of the Coastal Plain of North Carolina, by William Bullock Clark, B. L. Miller, L. W. Stephenson, B. L. Johnson, and H. N. Parker, is in press as a publication of the North Carolina Geological and Economic Survey.

The manuscripts prepared during the fiscal year are noted in the accounts of the work of individuals engaged in the Coastal Plain investigations.

Mr. Vaughan has been assisted in his paleontologic studies by Dr. C. Wythe Cooke, who gave particular attention to Tertiary fossils, and by Dr. Joseph A. Cushman, who studied the collections of Foraminifera from several of the formations of the Coastal Plain and from the Canal Zone.

*Field work in the Coastal Plain investigation.*—L. W. Stephenson continued the study of the geology and underground waters of parts of the Atlantic and Gulf Coastal Plain. He studied the stratigraphy and paleontology of the Cretaceous formations which outcrop in the region between Arkadelphia, Ark., and Uvalde County, Tex. T. W. Stanton accompanied Mr. Stephenson in southwestern Arkansas and northeastern Texas. Between Austin and Uvalde County the work was of a detailed reconnaissance nature and included the differentiation of formational units, the determination of stratigraphic and age relationship, and the collection of fossils. This work was done in part in collaboration with Alexander Deussen. The remainder of the year was spent by Mr. Stephenson in office work, which included proof reading, the preparation of reports, the preparation and study of fossil material relating in part to his own work and in part to the work of others, and the answering of referred letters. Work was done on the preparation of reports as follows:

A paper entitled "A deep well at Charleston, S. C.," originally intended for outside publication, is nearly completed and will be submitted for publication as a bulletin.

A cooperative report on the underground waters of the Coastal Plain of Georgia has been nearly completed; the part of this report relating to the underground waters of the Cretaceous deposits was prepared by Mr. Stephenson, and the part relating to the Tertiary and Quaternary deposits was prepared by Otto Veatch, assistant State geologist of Georgia.

A report on the underground waters of northeastern Arkansas, originally prepared by A. F. Crider, is now being revised and brought up to date by Mr. Stephenson.

In continuation of the work begun in 1909, Edward W. Berry spent two months in making field studies and collections from the plant-bearing beds of the Eocene, Oligocene, Miocene, and Pliocene in Alabama, Mississippi, Tennessee, Kentucky, Arkansas, Louisiana, and Texas. The data thus obtained furnish important criteria for determining the climatic and other physical conditions in southeastern North America during the Tertiary period. Office work done by Mr. Berry during the year includes the completion of a monograph on the Upper Cretaceous flora of the Gulf Coastal Plain, a flora largely ancestral to the Tertiary flora, as well as systematic studies of the Tertiary floras.

Investigations of the geology and hydrology of the Coastal Plain of Texas have been continued by Alexander Deussen. The months of July, August, and September, 1911, were devoted to field work, the party being in charge of Mr. Deussen, with David Donoghue as assistant. Reconnaissance surveys of the following counties of the Coastal Plain were completed: Bexar, Wilson, Karnes, Bee, Refugio, Arkansas, San Patricio, Live Oak, and a part of Medina. Mr. Deussen has in preparation a report on the geology and underground waters of the central Coastal Plain region of Texas. This report is about 65 per cent completed. A considerable portion of the time devoted to it has been taken up with the collection of analyses and tabulation of the analytical data. Mr. Deussen has also revised a report on the geology and underground waters of Texas east of Brazos River and south of Marion County. Some three months of office work have been devoted to this revision, and the report has been largely rewritten.

At the beginning of the year G. C. Matson was engaged in preparing a report on the phosphate deposits of Florida. This report was laid aside August 10 and field work on the upper Tertiary of the Gulf Coastal Plain was resumed where it had been abandoned in December, 1910. During the field season an area extending from south-central Mississippi to Alexandria, La., was examined in sufficient detail to permit a thorough revision of the former classification of the upper Tertiary formations. The field operations were suspended in November and were not resumed until May 1, 1912. During May the investigations of the previous season were extended to Sabine River and an excursion was made into eastern Texas for the purpose of correlating the work in Louisiana with that in Texas.

The months of January, February, and March were devoted to office work, and during this time Mr. Matson revised his report on

the geology and underground waters of Florida and completed his report on the phosphate deposits of Florida. In addition, he prepared a brief report on the clay deposits of Delaware and submitted it for publication as a part of Bulletin 530.

During April data were collected for a more detailed correlation of the upper Tertiary of Florida.

June 1 to 15 was devoted to a study of the oil field near Easton, La., and a detailed map was prepared showing the location of the wells and the topography of the salt dome with which the oil sands are associated. The collection of records of wells recently drilled has enabled Mr. Matson to outline the area where the structure seems favorable to the occurrence of oil.

A study of the process of sedimentation at the mouth of the Mississippi was undertaken during the last half of June.

#### SECTION OF PALEONTOLOGY AND STRATIGRAPHIC GEOLOGY.

T. W. Stanton continued to supervise the section of paleontology and stratigraphic geology.

At the beginning of the year Mr. Stanton was in the field with the party under M. R. Campbell, engaged in the study of the geology of the Glacier National Park and adjacent portions of the Blackfeet Indian Reservation. He studied the Mesozoic rocks exposed near the southern and eastern boundaries of the park and, with Eugene Stebinger, made an examination of the Cretaceous section along Cutbank Creek from the mountains to its junction with Two Medicine Creek. After leaving Mr. Campbell's party on August 18, Mr. Stanton examined some sections of Kootenai and associated rocks in the neighborhood of Great Falls and Belt, Mont., and then proceeded to Ashdown, Ark., to join L. W. Stephenson, with whom, from September 2 to September 13, he made a reconnaissance study of the Cretaceous formations at several localities between Ashdown and Sherman, Tex.

A large part of Mr. Stanton's time in the office was employed in making preliminary studies of current collections of Mesozoic invertebrate fossils and in preparing reports on them for the use of other geologists. The rest of his time was occupied by the reading of manuscripts, committee work, and administrative duties connected with the supervision of the section. A large increase in his committee work was caused by his appointment on March 23 to the chairmanship of the committee on geologic names.

Field studies on the early Paleozoic formations of Tennessee, Virginia, Missouri, and Arkansas were carried on during the summer of 1911 by E. O. Ulrich, assisted by Edwin Kirk and R. D. Mesler. These studies in Missouri and Arkansas were resumed in May and continued to the end of the year. In the office Mr. Ulrich continued

his general investigations of Paleozoic paleontology and stratigraphy and made the usual reports on collections for other geologists. He prepared for publication papers on the Clinton formation in the Appalachian region and on the Chattanooga shale and related formations. An illustrated work on the "Ozarkian" fauna was also brought nearly to completion and some progress was made on the text of the *Cincinnati folio*. Mr. Kirk acted as paleontologic assistant and Mr. Mesler attended to the routine work of preparing and caring for the collections.

H. S. Williams has continued work on a monograph of the Silurian and Devonian faunas of the Eastport quadrangle, Maine.

After completing work on the Niagara quadrangle, elsewhere referred to, E. M. Kindle continued his field studies on the correlation of Devonian formations. The problem of the correlation of the Chattanooga and Ohio shales was taken up in detail. In the field work Mr. Kindle was assisted for six weeks by P. V. Roundy. He prepared two papers on the results of the study of the Devonian shales south of Lake Erie and nearly completed a third manuscript on the Hamilton fauna of the Allegheny region. A considerable amount of Mr. Kindle's time has been spent in preparing special reports on collections of Devonian fossils made by other geologists who desired lists of species and determinations of horizons represented.

In the office R. D. Mesler and P. V. Roundy have both assisted Mr. Kindle for short periods in preparing the Devonian collections for study and reference.

G. H. Girty was employed in field work during July, August, and September, and spent the remainder of the year in the office. In the field he was engaged on problems connected with the stratigraphy and correlation of Carboniferous rocks in Kentucky, Tennessee, Arkansas, Missouri, Iowa, Kansas, Utah, Nevada, and Idaho. He was associated with Mr. Butts in Tennessee, Mr. Hinds in Kansas, and Messrs Umpleby and Richards in Idaho. In the office his time was devoted to elaborating data collected and to preparing reports on collections of fossils referred to him by other geologists. He completed for publication two papers on Carboniferous faunas from Arkansas. During most of the year he was assisted in routine preparatory work on collections by P. V. Roundy, who also spent one month collecting fossils and measuring sections in Georgia and Alabama.

The investigation of the marine Triassic formations of the Western States was continued, both in the field and in the laboratory, by J. P. Smith, who almost completed his monograph on the Upper Triassic fauna and made considerable progress on the monograph on the Lower Triassic.



All the work of preparing, recording, and caring for the collections of Mesozoic invertebrates and of fossil plants was done by T. E. Williard, who also during the year rearranged the reserve collections of fossil plants so that they are now easily referred to.

In connection with his stratigraphic work on the Cretaceous formations of the Gulf Coastal Plain L. W. Stephenson has made preliminary studies of the associated faunas.

A monograph on the Mesozoic and Cenozoic Echinodermata of the United States, by W. B. Clark and M. W. Twitchell, has been completed and transmitted for publication.

In addition to supervising geologic work in the Atlantic and Gulf Coastal Plain, T. W. Vaughan (see p. 50) continued his studies of recent and fossil corals, and, under his direction, late in the year, C. W. Cooke began work on the accumulated collections of Eocene mollusks. J. A. Cushman has begun to prepare a monograph on the Tertiary and Cretaceous Foraminifera of the Coastal Plain. A report on the Tertiary paleontology of Virginia and North Carolina, by Julia A. Gardner and a number of collaborators, is in preparation. The work of cleaning, assorting, and recording Tertiary invertebrates for Mr. Vaughan was done by I. B. Millner.

The work of W. H. Dall on tertiary invertebrate paleontology has this year consisted chiefly in the preparation and preliminary study of the large collection of fossils from the Canal Zone and adjacent areas in Central America, which was received from the Isthmian Canal Commission in October. The elaboration of this paleontologic material from the Isthmus of Panama should aid greatly in solving many important problems concerning the distribution of animals and plants and the geologic history of both North and South America. Mr. Dall also made considerable progress in his description of the fauna of the Oligocene "silex beds" of Tampa, Fla., which he is preparing for publication as a bulletin. The current work of recording, preparing, classifying, and reporting on collections and indexing the literature of Tertiary paleontology was kept up with the assistance of W. C. Mansfield.

David White has made the usual preliminary studies and reports for geologists on collections of Paleozoic fossil plants and has continued monographic investigations of the Paleozoic floras so far as his administrative duties would permit.

F. H. Knowlton continued the study of Mesozoic and Cenozoic fossil plants. For about four months and a half he was making preliminary examinations of the large current collections, mostly from the Rock Mountain area, and in preparing reports on them for the use of geologists. The remainder of the year he devoted to monographic work on the fossil plants of Raton Mesa, in northern New Mexico and southern Colorado, which will result in a large descrip-



tive volume, now nearly completed. Several short papers on paleobotanic subjects were prepared for outside publication during the year.

Under the joint supervision of Messrs. Knowlton and White, the work on the bibliography and compendium of paleobotany has been continued by Miss C. H. Schmidt, assisted by Miss I. P. Evans. This work is now practically completed to the close of 1910, all that remains being in the nature of a revision of American geologic horizons, editorial revision, and preparation for the printer.

E. W. Berry has nearly completed a report on the Eocene flora of the Southern States.

Through the courtesy of the United States National Museum all the collections of vertebrate fossils sent in by Survey field parties have been examined and reported on by J. W. Gidley and C. W. Gilmore.

#### SECTION OF ECONOMIC GEOLOGY OF METALLIFEROUS ORES.

*Work of chief of section.*—The chief of the section of economic geology of metalliferous ores, Waldemar Lindgren, devoted some time in the summer to field work in Utah, Nevada, and California, which is mentioned in detail below. The winter he spent in Washington, giving his time mainly to the administrative work of this section and to the work of the division of mineral resources relating to metallic production. In October, 1911, he visited Deadwood, S. Dak., and Idaho Springs, Colo., for conference and inspection. From November 20 to December 19 he was absent on leave without pay, giving a course of lectures at the Massachusetts Institute of Technology. The administrative duties of this section and those of the office of chief geologist occupied his time during the remainder of the year.

*Eastern and Central States.*—Little work was done in the Eastern and Central States. W. H. Emmons and F. B. Laney continued office work on a report on the Ducktown copper district, Tennessee, during such time as they could spare from their other work.

C. E. Siebenthal, who gave the larger part of his time to the preparation of chapters on lead, zinc, and cadmium for the division of mineral resources, also spent five months in completing a report on the genesis of the lead and zinc ores of the Joplin district, which will be published as a bulletin of the Survey. The discussion of the genesis of these ores grew out of the study of the ores of the Wyandotte quadrangle and is contributory and necessary to the completion of the folio and the economic report on that quadrangle.

*Western States.*—In Colorado field examinations were carried on at Creede and in the Gilpin County districts. E. S. Bastin spent four months and a half, assisted by J. M. Hill and for part of the

time by C. W. Henderson, in completing the field study of the economic geology of the Central City region, mainly a district of gold and silver bearing veins. The office work will be completed during the summer of 1912.

W. H. Emmons spent August and the first part of September in an examination of the metalliferous veins of the Creede mining district, Colo. In this work he was associated with E. S. Larsen, jr., who examined the areal geology of the district. Owing to the appointment of Mr. Emmons as professor of geology at the University of Minnesota, the field work was not completed, but it will be taken up in the summer of 1912. Mr. Emmons spent such time as he could spare from his regular work at the university in preparing a preliminary report on the Creede district (Bulletin 530-E).

The preparation of a final report on the ore deposits of Leadville, which had been interrupted by the death of S. F. Emmons in March, 1911, was intrusted to Prof. J. D. Irving, of Yale University, who for a number of years had assisted Mr. Emmons in the field and office work relating to this district. Prof. Irving continued this work during the winter and was aided by a draftsman engaged by the Survey to complete the geologic sections and maps of this district.

F. L. Hess undertook a reconnaissance of the vanadium (roscoelite) deposits in the vicinity of Placerville, Colo., in connection with a general reconnaissance of such deposits in several other States. A preliminary report was published in Bulletin 530-K. A bulletin on the crystallography and mineralogy of ferberite, mainly that of Boulder County, Colo., was prepared and submitted by Mr. Hess and W. T. Schaller. A considerable part of Mr. Hess's time was occupied in preparing reports on the production of the rare metals for the division of mineral resources.

In Wyoming D. F. Hewett, a member of the section of western fuels, examined the copper prospects of the Sunlight Basin and prepared some notes on them for publication in Bulletin 530-O.

In New Mexico F. L. Hess visited the vanadium districts in the Caballos district, a description of which was incorporated in Bulletin 530-K.

In Arizona a detailed study of the geology and ore deposits in the Tombstone district was made by F. L. Ransome. He also finished the field work for reports on the disseminated copper deposits of Ray and Miami and has nearly ready for publication the text and maps of the Ray folio. In connection with the work at Tombstone Mr. Ransome made a reconnaissance examination of the Turquoise district, the results of which were published as Bulletin 530-C. In preparation for a general report on the geology and ore deposits of Arizona, he also made a brief examination of the Bisbee district and visited the Superior and Jerome districts. During the winter Mr.

Ransome was occupied in preparing reports on the districts mentioned.

F. C. Schrader devoted the last months of the fiscal year to the preparation of a report on the mineral deposits of the Santa Rita and Patagonia Mountains, the field work of which had been completed during the previous year.

In Utah field work was continued during the summer of 1911 and also during May and June, 1912, by B. S. Butler. He examined the Marysvale, Silver Reef, Clifton, Spring Creek, Fish Springs, Dugway, Granite, Lucin, and other districts. During the winter Mr. Butler completed a professional paper on the ore deposits of the San Francisco and adjacent ranges. Together with H. S. Gale, Mr. Butler prepared a bulletin on the occurrence of alunite in the Marysvale district (Bulletin 511).

Waldemar Lindgren, assisted by G. F. Loughlin, completed during the fall a reexamination of the Tintic district, undertaken for the purpose of recording the important developments that had taken place since the district was examined by George Otis Smith and G. W. Tower. A report on the district is in preparation.

F. L. Hess examined the vanadium deposits in the San Rafael Swell near Green River and prepared a short report on them for publication in Bulletin 530-K.

A short paper on the economic geology of the La Sal Mountains, based on field work of the previous year, was prepared by J. M. Hill and published as Bulletin 530-M.

In Idaho J. B. Umpleby spent two weeks in 1911 in revisiting the Texas mining district in Lemhi County. He also spent four weeks in a geologic reconnaissance of the Bayhorse, Yankee Fork, and Loon Creek mining districts, in northwestern Custer County. The reports on both these areas have been submitted. Late in June he returned to Idaho and started a geologic reconnaissance in the vicinity of Mackay. A preliminary account of the ore deposits of the Loon Creek district was published in Bulletin 530-G.

In connection with the geologic mapping of the Taft quadrangle, Idaho and Montana, F. C. Calkins and E. L. Jones, jr., prepared a short paper on the geology and mineralization of the St. Joe-Clearwater region, which was published in Bulletin 530-G.

In Montana economic field work was carried on near Helena and in the Dillon region. During the field season of 1911 Adolph Knopf, assisted by H. G. Ferguson, mapped the geology and studied the ore deposits of an area of 1,300 square miles in central-western Montana on a scale of 1:250,000. This area includes a large number of mining camps extending from Marysvale on the northwest to Elkhorn on the southeast. A report embodying the results of the field observations was prepared during the winter and submitted for publication.

During July and August A. N. Winchell completed field work in the mining districts in southwestern Montana continued from last year. During the winter Prof. Winchell devoted such time as he could spare from his regular duties to preparing a report on the field work of the two seasons. The report will be completed during the summer of 1912. On June 11 Prof. Winchell resigned as assistant geologist in the Survey.

In Washington no field work was undertaken, but a report on the ore deposits of the northeastern part of the State, for which the field work had been completed during the previous year, was finished by Howland Bancroft. Mr. Bancroft resigned May 31 as assistant geologist in the Survey.

In Oregon the only field work relating to the examination of ore deposits was done by J. S. Diller, who during the summer of 1911 surveyed a number of smaller mining camps in the Kerby and Galice mining districts, in the southwestern part of the State. Mr. Diller spent a part of the winter in preparing a report on this region.

In California practically no field work relating to metalliferous deposits was undertaken. Mr. Lindgren spent some days in investigating the gold-dredging deposits of the central part of the State, at Marysvale and Folsom. D. F. MacDonald prepared a paper on the gold lodes of the Carrville district, Trinity County, which was published as Bulletin 530-D, the field work having been completed in a previous year.

Progress was made by F. L. Hess in the preparation of the report on the Randsburg gold-mining district.

L. C. Graton, under contract to complete a report on the copper mines of Shasta County based on the field work of previous years, states that the report will be completed in the summer of 1912.

In Nevada F. C. Schrader began a reconnaissance of the Wonder, Fairview, and Rawhide mining districts. During part of the time he was assisted by H. S. Gale. The work was unexpectedly interrupted by Mr. Schrader's assignment to the examination of mining properties in Nevada for the Department of Justice. On returning to the Washington office in the spring he continued the preparation of his report on a geologic reconnaissance in Arizona. Mr. Schrader also prepared a paper on the Antelope district, which was published as Bulletin 530-J. In August Mr. Lindgren completed the survey of the National mining district, in the northern part of Nevada. A report on this district is in preparation.

*Miscellaneous general work.*—During the year W. H. Emmons completed a report on the enrichment of sulphide ores, consisting of a general discussion and a compilation of the data contained in the literature on American mining districts published since 1900. It will be published as Bulletin 529.

J. M. Hill devoted some time to the completion of Bulletin 507, containing a descriptive list and maps of the mining districts of the Western States. Waldemar Lindgren prepared a geologic introduction for this bulletin.

In April, May, and June R. W. Stone, assisted by E. L. Jones and H. G. Ferguson, was detailed to complete and revise a report on the occurrence of industrial minerals in the United States, which will be issued as a part of the annual volume "Mineral resources of the United States."

B. S. Butler made short visits to the Lake Superior copper district, in Michigan, and the Butte district, in Montana, and prepared a report on the production of copper in the United States for the division of mineral resources.

*Examinations for other departments.*—At the request of the Department of Justice F. C. Schrader was detailed in September to make an examination of mining properties in the Bovard, Goldfield, and Diamond Field mining districts, Nev., and his services were subsequently continued in connection with this work for the department in the Federal district court at New York until March.

In December J. M. Hill, on a request from the Department of Justice, was detailed to make an examination of the properties of a mining company in Shasta County, Cal. The completion of the report on this property occupied his time until the middle of February.

At the request of the Post Office Department E. F. Burchard and D. F. Hewett were detailed to make a brief preliminary investigation of alleged deposits of manganese and iron ore, ocher, marble, and limestone in western Maryland near Harpers Ferry, W. Va., and gave testimony on the subject before the Federal grand jury at Baltimore, Md.

In March, 1912, the newspapers announced the discovery of a billion tons of iron ore in Pennsylvania. G. H. Ashley was detailed at once to investigate the matter, and his findings, failing to substantiate the discovery, were published widespread the following week through the medium of a special press bulletin.

*Classification of Northern Pacific Railroad lands.*—An item in the sundry civil act of June 25, 1910, being an amendment to the act of February 26, 1895 (Stat. L., vol. 28, p. 683), entitled "An act to provide for the examination and classification of certain mineral lands in the States of Montana and Idaho," made an appropriation to the General Land Office for completing the classification, as to their mineral or nonmineral character, of certain specified lands within the grant of the Northern Pacific Railroad in Montana and Idaho. Under the authority of the Secretary of the Interior the field examination and the classification of these lands were assigned to the



Geological Survey. An additional appropriation was made for this purpose in the sundry civil act of 1911 and the work was completed during the present fiscal year. F. C. Calkins, assisted by E. L. Jones, jr., completed examinations in the St. Joe and Clearwater basins, Idaho.

J. T. Pardee was occupied during almost the entire year in classifying lands in western Montana. In the winter he was mainly occupied in preparing data for the land-classification board. From January 18 to February 12 he attended the hearing at the land office at Cœur d'Alene, Idaho, giving testimony, together with H. S. Gale, in cases contested by the Northern Pacific Railway.

R. W. Stone was engaged during the greater part of the year in classifying many small and widely scattered tracts in central Montana. He was assisted in the field by Prof. Bert Kennedy, of Illinois.

*Classification of lands in Indian reservations.*—A sum having been set aside by the Indian Office for separating the mineral from the nonmineral lands in the Colville Indian Reservation, Wash., J. T. Pardee was detailed to this duty on June 1 and spent the month of June in organizing and beginning the work.

#### SECTION OF ECONOMIC GEOLOGY OF NONMETALLIFEROUS MINERALS.

*Work of chief of section.*—During the first part of the year F. B. Van Horn was engaged largely in administrative duties in Washington. From September 3 to October 8 he spent some time visiting field parties in Idaho and Oregon, but on account of the resignation of C. W. Hayes, chief geologist, he returned to Washington, serving as acting chief geologist between the date of the resignation of Mr. Hayes and that of the appointment of Mr. Lindgren. From May 14 to May 31 Mr. Van Horn spent some time in Kentucky and Tennessee visiting reported phosphate deposits. The rest of the year he spent in administrative work for the geologic branch and as acting chief geologist. He also prepared a report on the production of phosphate rock in 1911 for publication in the volume "Mineral resources of the United States."

*Eastern and Central States.*—A detailed investigation of the Clinton and other red iron ore deposits of the Appalachian region in eastern Tennessee, northeastern Alabama, and northwestern Georgia was carried on by E. F. Burchard. The field work of this investigation occupied most of his time from the middle of July to the end of November. The work in Tennessee was done in cooperation with the State Geological Survey, and that in parts of Tennessee, Alabama, and Georgia near Chattanooga in cooperation with the Chattanooga Chamber of Commerce. For the purpose of obtaining exact measurements and fresh samples of ore Mr. Burchard, with the assistance of J. R. Ryan, a practical mining superintendent,

systematically prospected the ore beds at intervals ranging from half a mile to 5 miles along more than 250 miles of outcrop—a method which is new to Survey practice in the investigation of metalliferous ores but which yielded definite and valuable information on many hitherto uncertain points. The preparation of two bulletins based on this field work is under way—a description of the red iron ores of eastern Tennessee, to be published by the Tennessee Geological Survey, and a description of the red iron ores of eastern Tennessee, northeastern Alabama, and northwestern Georgia, to be published by the United States Geological Survey.

Mr. Burchard prepared considerable material for a bulletin by E. C. Eckel on the Portland cement materials and industry of the United States, the manuscript and illustrations of which were submitted for publication as Bulletin 522. He also prepared reports on the production of iron and manganese ores, fluorspar, cement, building stones, lime, gypsum, glass sands, and concrete materials, for publication in the volume "Mineral resources of the United States."

W. C. Phalen made a study of the salt industry in the United States, with special reference to the occurrence of potash salts in brines and bitterns or associated with rock salt. The analytical work connected with the investigation is now being done by the Bureau of Soils, Department of Agriculture, but is not yet finished, and the detailed report must await these analytical results. During the course of the work Mr. Phalen visited New York, Michigan, Ohio, West Virginia, Pennsylvania, Kansas, and Louisiana. A short report embodying part of the results obtained on this trip was prepared and published as Bulletin 530-B.

The work in connection with the search for potash salts was placed in charge of Hoyt S. Gale. The early part of the field season was devoted to a review of the saline deposits in the Laramie Basin, southern Wyoming. This was followed by the selection of a drilling equipment and a site for preliminary drilling and the subsequent installation of the drilling equipment near Fallon, Nev., with J. H. Hance in charge of the outfit.

Investigations as to the finding of commercial supplies of potash salts have been concentrated along the following lines:

1. The exploration, by deep boring, for deposits of buried salines in Nevada and in other localities in the western public-land States, by a party in charge of J. H. Hance, under the direction of Hoyt S. Gale.

2. The investigation of the occurrence of certain rich potash-bearing rocks and minerals, described in short reports.

3. The investigation of the salt deposits and the brines and bitterns in the United States east of the Rocky Mountains, carried on by W. C. Phalen, under the supervision of David T. Day.



4. A limited amount of general field work in the Western States by Hoyt S. Gale.

Naturally work on such a subject as this has not been concluded within a single year, but preliminary reports have been prepared on the progress of the Government boring near Fallon, Nev., by Hoyt S. Gale (Bulletin 530-A); on the investigation of the salines east of the Rocky Mountains, by W. C. Phalen (Bulletin 530-B); on the discovery of a new deposit of alunite near Marysvale, Utah, as a possible source of potash, by B. S. Butler and Hoyt S. Gale (Bulletin 511); on the extent and distribution of leucite rock in southern Wyoming as a possible source of potash, by Whitman Cross and A. R. Schultz (Bulletin 512); and on the occurrence of nitrates in the United States, by Hoyt S. Gale (Bulletin 523). A general review of the subject is contained in a chapter from "Mineral resources" entitled "Potash salts, summary for 1911," by W. C. Phalen.

During the summer of 1911 Eliot Blackwelder made a survey of the Gros Ventre Mountains, in western Wyoming, and the west end of the Wind River Range, part of the district reconnoitered by him in 1910. During the winter special reports and plats, to serve as a basis for classifying the phosphate lands in the area surveyed, were prepared for 33 townships.

R. W. Richards, assisted by G. R. Mansfield, made a detailed examination of eight townships in the Wayan quadrangle, southeastern Idaho. These townships included large areas of phosphate lands. A preliminary report has been prepared and submitted for publication.

Messrs. Richards and Mansfield also continued the examination of the Montpelier quadrangle, Idaho.

In company with A. R. Schultz, Mr. Richards made a rapid reconnaissance of that portion of Idaho lying south of Snake River and north of the areas mapped and studied in detail by Messrs. Richards and Mansfield in 1910 and 1911. The data collected warranted the elimination from the phosphate reserve of large areas which had been originally included on the basis of the mapping by the Hayden Survey in 1877. A report of this reconnaissance examination was prepared and submitted for publication in Bulletin 530-H.

#### SECTION OF ECONOMIC GEOLOGY OF FUELS.

##### WORK OF CHIEF OF SECTION.

During the fiscal year M. R. Campbell remained in general charge of the fuel section. From the beginning of July to the middle of October he was engaged in areal mapping in the Glacier National Park and vicinity, Mont. During the remainder of the year Mr. Campbell was engaged in general administrative duties connected

with the fuel section and in preparing reports for publication. The most important of these was Bulletin 471, "Contributions to economic geology, 1910, Part II." Owing to the delay in preparation this is an unusually large volume and required a large amount of work in revision and editing before it was ready to submit for publication. In addition to the report, a paper by Alfred R. Schultz on the geology of central Uinta County, Wyo., was revised and submitted for publication as a bulletin of the Survey, a report on the Standing Rock and Cheyenne River Indian Reservations was almost completed, and considerable progress was made in assembling and revising papers for Bulletin 531, "Contributions to economic geology, 1911, Part II." Mr. Campbell has also made a new estimate of the coal resources of the United States for consideration at the meeting of the International Geological Congress in Ottawa, Canada, in 1913.

#### CLASSIFICATION OF SUPPOSED COAL AND OIL LANDS.

The examination of coal and oil fields in the public-land States for classification was continued during the summer of the present fiscal year. Mr. Campbell was assisted by E. G. Woodruff and W. R. Calvert, the former exercising close personal supervision in both field and office and the latter for a few months only in the field. The following list includes projects examined and those in which the work was in progress at the end of the fiscal year. It also contains brief notice of reports that are in progress or have been completed, and the names of the geologists who have carried on the work.

Big Muddy lignite field, Perkins County, S. Dak. Geologic party in charge of D. E. Winchester examined in detail 1,680 square miles of supposed lignite land. Land classified and geologic report prepared.

Little Missouri River lignite field, Harding County, S. Dak. Geologic party in charge of E. M. Parks examined in detail 1,595 square miles of supposed lignite land. Land classified and geologic report prepared.

Marmarth lignite field, Billings County, N. Dak. Geologic party in charge of C. J. Harnes examined in detail 1,070 square miles of supposed lignite land. Land classified and geologic report in preparation.

Williston lignite field, Williams County, N. Dak. Geologic party in charge of F. A. Herald examined in detail 620 square miles of supposed lignite land. Work interrupted September 16 by detail of Mr. Herald to make an examination of a part of the Fort Berthold Indian Reservation. Land classified and geologic report prepared.

Fort Berthold Indian Reservation (south of Missouri River), N. Dak. Geologic party in charge of F. A. Herald examined in detail 270 square miles of supposed lignite land. Work extended from September 20 to November 10. Land classified and geologic report prepared.

Fort Berthold Indian Reservation (north of Missouri River), N. Dak. Geologic report of work done by M. A. Pishel in 1910 submitted (in Bulletin 471).

Little Sheep Mountain lignite field, Rosebud, Custer, and Dawson counties, Mont. Geologic party in charge of G. S. Rogers examined in detail 1,440

square miles of supposed lignite land. Land classified and geologic report prepared.

Fort Peck Indian Reservation, Valley County, Mont. Geologic party in charge of C. M. Bauer examined 2,016 square miles, part in reconnaissance and part in detail. Land classified.

Baker lignite field, Custer County, Mont. Geologic report of work done by C. F. Bowen in 1910 submitted (in Bulletin 471).

Terry lignite field, Custer County, Mont. Geologic report of work done by F. A. Herald in 1910 submitted (in Bulletin 471).

Glendive lignite field, Dawson County, Mont. Geologic report of work done by J. H. Hance in 1910 submitted (in Bulletin 471).

Sidney lignite field, Dawson County, Mont. Geologic report of work done by Eugene Stebinger in 1910 submitted (in Bulletin 471).

Several lignite fields in eastern Montana. Report on geology by W. R. Calvert submitted (in Bulletin 471).

Culbertson lignite field, Valley County, Mont. Geologic report of work done by A. L. Beekly in 1910 submitted (in Bulletin 471).

Big Snowy Mountains coal field, Fergus County, Mont. Geologic party in charge of W. R. Calvert made reconnaissance survey of 972 square miles of possible coal land. Examination completed July 9, 1911. Land classified and report prepared.

Part of Milk River coal field, Chouteau County, Mont. Report begun by L. J. Pepperberg submitted (in Bulletin 471) by G. B. Richardson.

Tertiary coal fields of western Montana. Examination made by J. T. Pardee in connection with his examination of Northern Pacific Railway land grant in that part of the State. Lands classified and report prepared.

Blackfeet Indian Reservation, Teton County, Mont. Eugene Stebinger examined 1,512 square miles, partly in detail and partly in reconnaissance. Land classified and some progress made on geologic report.

Geologic party in charge of M. R. Campbell examined about 500 square miles in connection with the survey of the Glacier National Park. Land classified.

Bull Mountain coal field, Musselshell County, Mont. Field work done in previous years by R. W. Richards and C. T. Lupton. Geologic report completed by E. R. Lloyd.

Livingston and Trail Creek coal fields, Sweetgrass, Park, and Gallatin counties, Mont. Geologic report of work done by W. R. Calvert in 1908 submitted (in Bulletin 471).

Upper Stillwater Basin, Sweetgrass and Carbon counties, Mont. Geologic report of work done by W. R. Calvert in previous years submitted for publication.

Hound Creek district of Great Falls coal field, Cascade County, Mont. Geologic report of work done in 1909 by V. H. Barnett submitted for publication.

Electric coal field, Park County, Mont. Geologic report of work done by W. R. Calvert in 1908 submitted (in Bulletin 471).

Chehalis coal field, Cowlitz and Lewis counties, Wash. Examination made by A. J. Collier during July and August, 1911.

Belle Fourche Valley coal field, Weston and Converse counties, Wyo. Geologic party in charge of V. H. Barnett examined in detail 1,430 square miles of coal land. Land classified and geologic report partly prepared.

Little Powder River coal field, Crook County, Wyo. Geologic report of work done by John A. Davis in 1910 submitted (in Bulletin 471).

Buffalo-Sheridan coal field, Johnson and Sheridan counties, Wyo. Geologic party in charge of C. H. Wegemann examined in detail 90 square miles of coal land in connection with stratigraphic work along the east front of the Bighorn Mountains. Land classified.

**Sussex coal field, Johnson County, Wyo.** Geologic report of work done by C. H. Wegemann in 1910 submitted (in Bulletin 471).

**Barber coal field, Johnson County, Wyo.** Geologic report of work done by C. H. Wegemann in 1909 completed.

**Powder River oil field, Johnson County, Wyo.** Geologic report of work done by C. H. Wegemann in 1910 submitted (in Bulletin 471).

**Lost Springs coal field, Converse County, Wyo.** Geologic report of work done by D. E. Winchester in 1910 submitted (in Bulletin 471).

**Oregon Basin and Meeteetse quadrangles, Park County, Wyo.** D. F. Hewett, working in conjunction with a topographic party, examined in great detail 410 square miles of possible coal and oil land. Land classified.

**Wind River coal region, Fremont and Natrona counties, Wyo.** Geologic report of work done in 1908, 1909, and 1910 by E. G. Woodruff and D. E. Winchester submitted (in Bulletin 471).

**Portion of central Uinta County, Wyo.** Geologic report, based on field work by party in charge of A. R. Schultz in 1906, submitted for publication as separate bulletin.

**Snake River valley, Idaho.** C. F. Bowen, with one assistant, examined in a rapid reconnaissance 10,224 square miles of possible coal land. Land classified and two short geologic reports submitted.

**Northwestern Oregon.** Geologic report of work done by C. W. Washburne in 1910 on oil prospects submitted for publication.

**North Park coal field, Jackson County, Colo.** Geologic party in charge of A. L. Beekly examined in detail 1,777 square miles and covered by reconnaissance examination about 250 square miles additional. Land classified and geologic report prepared.

**Meeker quadrangle, Rio Blanco County, Colo.** E. T. Hancock, in conjunction with a topographic party, examined in great detail 216 square miles. Land classified and geologic report in course of preparation.

**Glenwood Springs coal field, Garfield and Pitkin counties, Colo.** Report on 216 square miles of coal field examined in great detail by A. L. Beekly in 1909 completed by G. S. Rogers.

**De Beque oil field, Mesa and Garfield counties, Colo.** Geologic report of work done by E. G. Woodruff in 1910 submitted (for Bulletin 531).

**Coal resources of Gunnison Valley, Mesa and Delta counties, Colo.** Geologic report of work done by E. G. Woodruff in 1910 submitted (in Bulletin 471).

**Mancos coal field, Montezuma County, Colo.** Geologic party in charge of Max A. Pishel examined in detail 829 square miles of supposed coal land. Land classified and geologic report in preparation.

**Castle Valley coal field, Emery County, Utah.** Geologic party in charge of C. T. Lupton examined in detail 500 square miles of supposed coal land. Land classified.

**Blacktail (Tabby) Mountain coal field, Wasatch County, Utah.** The examination of this field in 1910 was completed in the early part of the present fiscal year by the survey of 200 square miles of supposed coal land in the western part of the field. Land classified and geologic report submitted (in Bulletin 471).

**Deep Creek district of Vernal coal field, Wasatch and Uinta counties, Utah.** Geologic report of work done by C. T. Lupton in 1910 submitted (in Bulletin 471).

**Sunnyside quadrangle, Carbon County, Utah.** Frank R. Clark, in conjunction with a topographic party, examined in great detail 230 square miles. Geologic report in preparation.

**Coalville coal field, Summit County, Utah.** C. H. Wegemann examined in detail 70 square miles of coal land. Land classified.

Raton Mesa coal region, Colfax County, N. Mex., and Las Animas County, Colo. A comprehensive report on the stratigraphy of this region, by W. T. Lee, with descriptions of fossil plants, by F. H. Knowlton, is nearing completion. This report is the result of work done during this and previous seasons in the Raton Mesa region and also in several small coal fields of New Mexico.

Tijeras coal field, Bernalillo County, N. Mex. Geologic report submitted (in Bulletin 471) by W. T. Lee.

Silver Peak coal field, Esmeralda County, Nev., examined by J. H. Hance. Land classified and geologic report prepared.

Kern River oil field, Kern County, Cal., examined by geologic party in charge of R. W. Pack, under the direct supervision of Robert Anderson. The work embraced the examination not only of the Kern River field but also of adjacent territory on the east side of the San Joaquin Valley. Land classified.

South end of San Joaquin Valley, Cal. Preliminary report on the geology and possible oil resources (in Bulletin 471) prepared by Robert Anderson, as a result of field work of previous years.

Diablo Range, Cal. Geologic report on possible oil resources nearly completed by Robert Anderson, based on field work of previous seasons.

Pawnee, Otoe, Ponca, Kaw, and Tonkawa Indian reservations oil field, Okla. Reconnaissance examination made by R. H. Wood in spring of 1912. Report submitted (for Bulletin 531).

#### SUBSECTION OF FUELS EAST OF THE NINETY-SEVENTH MERIDIAN.

*Work of chief of subsection.*—David White held conferences and made examinations in the field with the cooperative parties, both Federal and State, engaged in the survey of the Waterloo, Milan, Carlyle, Okawville, and New Athens quadrangles, in Illinois; with the State geologist and field parties mapping the Missouri coal field and the Leavenworth quadrangle, the latter partly in Kansas; with those in the Vinita, Nowata, Claremore, and Shawnee quadrangles, in Oklahoma; those in the Pikeville, Crossville, and Rockwood quadrangles, in Tennessee; and those in the Wayne County oil fields of Kentucky. In these areas Mr. White aided the field geologists in correlation and in paleobotanic determinations of age.

Field paleontologic studies for correlating and grouping geologic formations were also made by Mr. White in Pawnee, Oklahoma, Logan, Atoka, and Pushmataha counties, Okla., and in Clay and Wichita counties, Tex.

At the close of the field season Mr. White made a brief examination of the phyllite near Worcester, Mass., to determine its geologic age; also, for the purpose of correlation, a hasty reconnaissance of the conglomerate at Dighton, Mass., to which Mansfield has given the name Dighton conglomerate, and of the series of beds near Dodgeville, Mass., which were included in the Tenmile River beds of Shaler, Woodworth, and Foerste. In addition to performing the administrative and committee work of the section, Mr. White has continued his studies of the regional variations of the Appalachian coals, concerning which he is preparing a paper. A small amount of



time has been available for examination and report on collections of Paleozoic plants submitted by several geologists.

*Northern Appalachian region.*—During the year no field examinations have been made of quadrangles in the coal, oil, or gas regions of Pennsylvania, the State Topographic and Geologic Survey Commission having insufficient funds for prosecuting cooperative field investigations.

The Foxburg-Clarion and Claysville folios (Nos. 178 and 180) and a report (Bulletin 454) on the coal, oil, and gas resources of the Foxburg quadrangle have been issued. Bulletins on the oil and gas resources of the Clarion and Sewickley quadrangles, prepared by M. J. Munn and transmitted several years ago by the Federal Survey for publication by the State Commission, have also been issued by the State.

The preparation of reports and folios covering the quadrangles already studied in the coal fields of Pennsylvania has progressed more rapidly since the return to the Federal Survey in March of George H. Ashley, who for nearly two years was State geologist of Tennessee. A bulletin on the economic geology of the Punxsutawney quadrangle has been prepared by him and a folio text for the same quadrangle has been nearly completed. The texts of folios covering the Curwensville and Houtzdale quadrangles are also well advanced. A folio for the Newcastle quadrangle, near the Ohio line in Pennsylvania, is also nearly ready for submission by F. W. De Wolf, whose time has been largely consumed by his duties as director of the State Geological Survey of Illinois. The folios mentioned, which will probably be submitted during the present calendar year, will complete the geologic descriptions and maps of the quadrangles in Pennsylvania that have been geologically surveyed in cooperation with the State.

*Southern Appalachian region.*—In Tennessee the valley rocks of the Pikeville 15-minute quadrangle have been thoroughly remapped by Charles Butts, in accordance with the most recent and complete differentiation and classification attained in other areas lately subjected by E. O. Ulrich and G. H. Girty to special paleontologic investigation. With the assistance of W. A. Nelson, of the Tennessee Geological Survey, with which the work was done in cooperation, Mr. Butts also mapped the geology of the Crossville quadrangle, besides making some reconnaissance examinations for the purpose of establishing more conclusively the identity between some of the sandstones of the Crossville quadrangle and those in the Standingstone and Briceville quadrangles described by Messrs. Campbell and Keith. In December, at the request of the State geologist, the services of E. Russell Lloyd were lent by this Survey to the State to make a detailed study of the geology of a tract known as the Herbert

domain, belonging to the State and located partly in the Pikeville 15-minute and Crossville quadrangles. The entire expense of the work was borne by the State of Tennessee.

The oil and gas developments over a large portion of Tennessee were examined by Mr. Munn, who under a cooperative agreement with the State Survey prepared short reports on the pools near Memphis and along Spring Creek in Overton County. These reports have been transmitted to the State geologist and published by the State.

In continuance of the oil and gas investigations earlier begun in cooperation with the Kentucky Geological Survey, Mr. Munn extended his examinations of the oil and gas pools of Wayne and Menifee counties and of the Ragland oil pool, in Bath and Rowan counties. A report by him on the oil and gas resources of Wayne County has been submitted for publication by the State. Preliminary reports on the Menifee, Bath, and Rowan County fields have been submitted for publication in Bulletin 531. Mr. Munn has in preparation also a general summary report describing the oil and gas developments of the southern Appalachian region.

The geology of the Cambrian and Ordovician formations in the Bessemer, Vandiver, and Columbiana quadrangles in Alabama was in June critically revised by Charles Butts, mainly to introduce a more exact and complete classification of the rocks. Two folio texts, covering the Bessemer and Vandiver quadrangles and the Montevallo and Columbiana quadrangles, have been prepared by Mr. Butts.

*Central States.*—In the Illinois coal field, where geologic surveying has for several years been in progress under cooperative agreements, E. W. Shaw has mapped the New Athens, Okawville, and Carlyle quadrangles and has revised the mapping of the Pleistocene formations of several other quadrangles surveyed by the State. He has submitted a folio text covering the New Athens and Okawville quadrangles and has written an economic report on the oil pools of the Carlyle quadrangle, which has been submitted for publication by the State.

In addition to performing the work above mentioned Mr. Shaw has arranged for folio publication a geologic report on the Belleville and Breese quadrangles. Jointly with A. C. Trowbridge, representing the State Survey, he has also prepared texts and maps for the Galena-Elizabeth folio and a State educational bulletin on the Galena-Elizabeth district.

In Iowa that portion of the Galena quadrangle lying west of Mississippi River has been geologically mapped at Federal expense by Mr. Shaw in order to acquire the data requisite for the completion of the Galena-Elizabeth folio.

The reconnaissance examination of the coal field of Missouri, begun in May, 1910, has been completed. In this work, which has been



carried on in cooperation with the State Bureau of Geology and Mines, Henry Hinds, the representative of the Federal Survey, has had for varying periods the assistance, in behalf of the State, of F. C. Greene, M. Albertson, and M. E. Wilson. Since the close of the field season in 1911 Mr. Hinds and Mr. Greene have been engaged in preparing a comprehensive economic report treating the entire coal field of Missouri by counties. This large and important report is now practically ready for transmission to be published by the State. In addition to the work more particularly of an economic nature, the Federal Survey has assisted in a reconnaissance examination of the upper Pennsylvanian rocks in the northwestern part of Missouri. The results of the work above described will be incorporated in a new geologic map to be issued by the State.

The detailed cooperative survey of a portion of the State of Missouri by quadrangles was begun in the summer of 1911 with the geologic mapping of the Leavenworth quadrangle, a portion of which lies in Kansas. In accordance with the plan for continuing the cooperation, the State began in June the detailed geologic investigation and mapping of the Queen City quadrangle.

In the region of the red beds of southwestern Oklahoma a very brief reconnaissance inspection was made in April by D. F. Hewett to determine whether the exposure of the beds and other conditions in that region are such as to encourage undertaking special structural studies of a kind particularly adapted to aiding the development of oil and gas resources.

#### WORK OF COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names was composed of Arthur Keith (chairman), M. R. Campbell (vice chairman), W. C. Alden, W. C. Mendenhall, F. L. Ransome, T. W. Stanton, G. W. Stose, and David White, until March 15. On that date Mr. Keith resigned from the chairmanship on account of pressure of other work and was succeeded by Mr. Stanton. On May 22 Mr. Mendenhall was succeeded by G. H. Ashley. The clerical work of the committee is performed by one clerk, Miss M. G. Wilmarth, who is designated as the secretary.

According to the Director's instructions of January 30, 1909, "It is the duty of the committee on geologic names to consider all geologic names used by members of the Geological Survey in both official and unofficial publications. When manuscripts are received by the committee they shall be examined as soon as practicable and the committee shall decide whether the names employed are permissible or not."

The chief objects of the committee are to insure uniformity in geologic classification and nomenclature in Survey publications, to prevent unnecessary duplication of geologic names, and to reduce if

possible the number of names employed, through correlation of the formations from one area to another. The main criteria on which the decisions of the committee are based are priority of publication, significance acquired by usage, and adequacy of definition and type locality. No one of these criteria is relied on to the exclusion of the others.

The records of the committee comprise (1) a catalogue of geologic names considered by the committee, arranged alphabetically, the action taken for each manuscript being recorded; (2) a catalogue of American geologic names in the literature, also arranged alphabetically, each published description of a formation being recorded (this catalogue is the work of J. M. Nickles, of the library staff); (3) a catalogue of the geologic names in the literature, arranged by States; (4) a catalogue of geologic columnar sections approved by the committee, arranged by States, the area to which each columnar section applies being located on the appropriate State map; and (5) a catalogue of geologic columnar sections in the United States, classified by States, compiled from existing literature, the areas being located on a set of State maps. The last catalogue is not complete but is being brought up to date as rapidly as possible. It is designed to prevent unnecessary duplication of geologic names. All these records, except as noted above, have been prepared and are kept up to date by the secretary of the committee.

The amount of labor and research which devolves upon the committee can be understood from the statement that during the last fiscal year it considered 143 manuscripts, comprising a total of 21,614 pages and about 5,000 geologic names. These manuscripts discussed the geology of all parts of the United States.

#### DIVISION OF ALASKAN MINERAL RESOURCES.

##### CLASSES OF WORK.

The work of the division of Alaskan mineral resources was carried on under an appropriation of \$100,000 for "continuation of the investigation of the mineral resources of Alaska." Under this authority, as in previous years, work of the following classes was carried on: Reconnaissance and detailed geologic surveys; special investigations of mineral resources; reconnaissance and detailed topographic surveys; investigation of water resources with reference to the supply available for placer mining; and collection of statistics on mineral production.

##### PERSONNEL.

The personnel of the division varied somewhat during the year on account of transfers of employees to and from other divisions and on account of temporary employment of technical assistants. On *July 1, 1911*, there were employed in the division 1 geologist in

charge, 10 geologists, 4 topographers, 2 engineers, 3 clerks, and 1 draftsman on annual salaries, 2 geologic field assistants, and 25 camp hands and recorders. On June 30, 1912, the personnel of the division included 1 geologist in charge, 11 geologists, 4 topographers, 2 engineers, 1 draftsman, and 3 clerks on annual salaries, 1 geologist and 1 clerk on per diem salary, and 2 geologic field assistants. One geologist, employed for six months during the year, is not included in the above enumeration.

**FIELD OPERATIONS IN SEASON OF 1911.**

*Allotments and areas covered.*—Thirteen parties were engaged in surveys and investigations in Alaska during the season of 1911 for varying periods between April 20 and October 26. In addition to these the geologist in charge spent a part of the summer in Alaska carrying on geologic investigations and visiting field parties.

During the year 14,460 square miles were covered by reconnaissance topographic surveys (on a scale of 1:250,000) and 246 miles by detailed topographic surveys (on a scale of 1:62,500). Detailed geologic surveys were made of 496 square miles and geologic reconnaissance surveys of 10,550 square miles. In addition to this 8,000 square miles were covered by exploratory geologic surveys. Most of the geologists also spent considerable time in studying special problems connected with the mineral deposits. The investigation of the water supply in placer districts covered an area of approximately 8,000 square miles and included the maintenance of 68 gaging stations and 309 measurements of stream volume. Twelve of the thirty mining districts of Alaska which are being developed were visited by members of the staff. The following table shows the allotment of the appropriation to the different districts of Alaska. These figures include the cost of both field and office work, as well as inspection.

*Allotment to Alaskan surveys and investigations in 1911.*

Copper River region .....	\$18, 500
Prince William Sound.....	4, 800
Kenai Peninsula.....	24, 500
Susitna basin.....	5, 100
Yukon basin.....	23, 700
Noatak region .....	11, 700
Northeastern Alaska .....	5, 500
General investigations.....	6, 200
	<hr/>
	100, 000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same party or even the same men may have carried on two different kinds of work, but this state-

ment will help to elucidate a later table which will summarize the complete areal surveys:

*Approximate allotments to different kinds of surveys and investigations in 1911.*

Geologic exploration .....	\$5,200
Geologic reconnaissance surveys .....	37,600
Special geologic investigations .....	7,500
Topographic reconnaissance surveys .....	25,500
Detailed topographic surveys .....	4,700
Investigation of water resources .....	6,500
Collection of statistics of mineral production .....	1,100
Miscellaneous, including clerical salaries, administration, inspection, instruments, office supplies, and equipment ..	11,900
	<hr/> 100,000

*Allotment for salaries and field expenses, 1911.*

Scientific and technical salaries .....	\$34,860
Field expenses .....	55,440
Clerical and other office salaries .....	9,700
	<hr/> 100,000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun in 1898. It should be noted that an unclassified amount—varying from year to year—is expended each year on special investigations that yield results which can not be expressed areally.

*Progress of surveys in Alaska, 1898-1911.\**

1898

1899

1900

\* The areas presented in this table differ somewhat from those previously published. This is due in part to the reclassification of the work and in part to the fact that the areas have been more carefully scaled from the maps than formerly.

\* In addition to the above, the International Boundary Survey and the Coast and Geodetic Survey have made surveys of parts of Alaska.

*General investigations.*—The geologist in charge was employed in office work until August, when he proceeded to Seattle and joined the party of the Secretary of the Interior. Details in regard to the itinerary of the Secretary's party have been published elsewhere, and it will therefore be sufficient to state here that parts of the Bering River coal field and of the Katalla oil field were visited and that the itinerary included journeys over the Copper River, Alaska Northern, and White Pass railways, down Lewis River to Lake Labarge, and over about 15 miles of the Valdez-Fairbanks military road. The geologist in charge left the party at Skagway on September 4 and proceeded to Juneau, where he spent two days in visiting some of the mines. Thence he returned to Valdez and devoted 10 days to a rapid reconnaissance of a part of the Port Valdez mining district. He reached Seward on September 24 and spent 10 days in studying the geology and mineral resources of a part of Kenai Peninsula, in company with Mr. Johnson and Mr. Martin. Conferences were also held in regard to topographic surveys with Mr. Sargent and Mr. Bagley. Returning, Mr. Brooks reached Seattle on October 15, proceeded to San Francisco to meet the Director, and, after attending the meeting of the American Mining Congress at Chicago, returned to Washington, arriving on October 28.

R. H. Sargent continued the general supervision of the topographic surveys and map compilation, in addition to carrying on his own field work. J. W. Bagley spent considerable time in devising methods and instruments for phototopographic surveys. These were successfully applied by him in his field work.

E. M. Aten continued to act as office assistant to the geologist in charge and supervised the office work while the geologist in charge was in the field. He also continued to assist in collecting the statistics of production of precious metals in Alaska.

Arthur Hollick, who was employed for six months, continued his study of the fossil flora of the coal measures of Alaska. W. W. Atwood also continued some office studies bearing on the coal resources of Alaska.

*Southeastern Alaska.*—Systematic surveys and investigations were begun in southeastern Alaska in 1901 and continued each season until 1910. The demands for surveys in other parts of the Territory prevented any further work in this province in 1911. This was unfortunate, for while the preliminary examination of much of this area has been completed and detailed surveys of the most important mining districts have been made, there is still great need for reconnaissance surveys which shall outline more definitely the geologic formations and thus furnish further evidence on the distribution of mineral resources.

Some office work was done during the year on a report treating of the region about Glacier and Lituya bays, by F. E. Wright.

C. W. Wright still has in hand the report on the copper deposits of the Kasaan Peninsula and Copper Mountain regions. His professional duties in Sardinia have prevented the completion of this report as early as he had hoped.<sup>1</sup>

*Copper River region.*—D. C. Witherspoon was assigned to the work of extending the reconnaissance survey southward from Hanagita Valley to the Bremner River region and revising the map of the lower Copper River valley. The party under his charge revised the mapping of an area of 900 square miles and surveyed a new area of 1,000 square miles, for publication on a scale of 1:250,000. Mr. Witherspoon also occupied some 20 triangulation stations which form part of a scheme for a system of triangulation from Copper Center to Chitina and from Chitina to the head of Bremner River.

F. H. Moffit, assisted by Theodore Chapin, made a geologic reconnaissance survey of about 1,500 square miles in the Hanagita Valley and Bremner River region. His party also examined the copper lodes and gold-placer prospects of the region.

*Prince William Sound.*—J. W. Bagley, assisted by C. E. Giffin, made a detailed topographic survey of the most important part of the Port Valdez mining district. Work in this district was begun on April 25 and continued until July 21, when the party was transferred to Kenai Peninsula. This survey was made by phototopographic methods. It covered an area of 160 square miles, for publication on a scale of 1:62,500, with 50-foot contours. A geologic reconnaissance of this area has already been made by A. H. Brooks. (See p. 75.)

*Kenai Peninsula.*—R. H. Sargent carried a topographic reconnaissance survey from Kachemak Bay northward to Turnagain Arm. The work included the revision and original mapping of part of the Sunrise placer district, and later the survey of the drainage basin of Resurrection River, near Seward. In all, an area of 3,100 square miles was surveyed, besides which the mapping of about 600 square miles was revised for publication on a scale of 1:250,000, with 200-foot contours.

J. W. Bagley, who began work in Kenai Peninsula on July 25 and continued it, so far as weather permitted, until October 13, made detailed topographic surveys of an area of 86 square miles (scale 1:62,500) in the Moose Pass region and also covered some 360 square miles by reconnaissance surveys, besides revising the mapping of an area of 170 square miles. These surveys were made by phototopographic methods.

G. C. Martin, assisted by Harmon Lewis, carried a geologic reconnaissance northward from Port Graham to Kenai River, thence eastward to the Alaska Northern Railway. In addition, Mr. Martin made some special geologic investigations in other parts of the

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<sup>1</sup>Mr. Wright has submitted his report since the close of the fiscal year.



peninsula. The Martin party mapped an area of 800 square miles on a scale of 1:250,000.

B. L. Johnson was assigned to the study of the developments of auriferous lodes in the northern half of Kenai Peninsula. He made a more or less detailed examination of most of the important lodes and gold placers of this district and mapped the geology of the area covered by Mr. Bagley's survey in the Moose Pass region.

*Susitna basin.*—S. R. Capps completed a geologic reconnaissance of the Yentna placer district. The area covered was about 2,000 square miles, and the work included the examination of all the important gold placers of the district.

*Yukon basin.*—L. M. Prindle, assisted by J. B. Mertie, completed the areal reconnaissance mapping of the larger part of the Circle quadrangle, covering an area of about 4,000 square miles. Mr. Prindle also made a study of the placers of Fourth of July Creek.

Henry M. Eakin completed the geologic reconnaissance mapping of the part of the Rampart quadrangle previously covered by topographic surveys. He also carried the work west of the Yukon, over a previously unmapped area, of which some topographic sketch maps were made. The Eakin party mapped an area of about 2,000 square miles and also examined the gold placers of the Rampart, Hot Springs, and Gold Mountain districts.

The investigation of the water resources of the Yukon-Tanana region, which was begun at Fairbanks in 1907, was continued. E. A. Porter carried on investigations in the Fortymile district, where 27 gaging stations were maintained for 17 weeks and 80 measurements were made; in the Eagle district, where 6 stations were maintained for 15 weeks and 28 measurements made; and in the Seventymile district, where 9 stations were maintained for 14 weeks and 46 measurements made. C. E. Ellsworth worked in the Birch Creek district, where 15 stations were maintained for an average of 15 weeks and 78 measurements were made; in the Fairbanks district, where 10 stations were maintained for an average of 15 weeks and 74 measurements made; and in the Salchaket district, where 1 station was maintained for 15 weeks and 3 measurements were made.

*Northeastern Alaska.*—By courtesy of the boundary commissioner, Mr. O. H. Tittmann, the Survey was enabled to attach a geologist to the party which was engaged in surveying the boundary north of Porcupine River. A. G. Maddren, assisted by J. M. Jessup, was detailed for this work. Field work began on the Porcupine and was extended northward. Topographic maps prepared by the boundary surveyors (scale 1:45,000) were used as a base, and the areal mapping covered about 400 square miles, in addition to which about 200 square miles were mapped in a reconnaissance way.

*Northwestern Alaska.*—P. S. Smith, with C. E. Giffin, topographer, carried an exploration up Alatna River, across the divide to the



Noatak, and down that river to the Arctic Ocean at Kotzebue Sound. An area of about 10,000 square miles was mapped topographically, and the principal geologic features of about 8,000 square miles of this area were mapped.

*Collection of statistics.*—The work of collecting statistics of the annual production of gold, silver, and copper in Alaska, begun in 1906, was continued during the year. The progress report for 1910 was completed in April, 1911, and published as Bulletin 480. This report contained the preliminary figures on mineral production, which were changed but little when the final figures were transmitted in August for inclusion in the Survey's annual volume "Mineral resources of the United States" for the calendar year 1910. The preliminary figures for mineral production in 1911 are included in the progress report for 1911, transmitted in June, 1912, and now in press as Bulletin 520.

#### FIELD OPERATIONS FOR SEASON OF 1912.

For many years the appropriation for continuing the investigation of the mineral resources of Alaska has been included in the annual urgent deficiency bill, and usually the money has been available not later than the 1st of February, so that parties have been dispatched to the remote parts of Alaska with the assurance that funds were available for continuing their work throughout the field season. Without such assurance the entering upon expensive field work would not be justified. In 1912, unfortunately, the Alaska item was put in the sundry civil bill, and the funds did not become available until after June 30. This condition has made necessary an entire change of field plans. Though supplies had been dispatched at heavy expense to Valdez Creek, to be used by parties which should extend surveys into the Broad Pass region, these surveys had to be abandoned because of the uncertainty of the appropriation. Other projected surveys in the Susitna and Matanuska basins also had to be given up.

The funds available until June 30 made it possible only to take up some of the more urgent work. A. G. Maddren was sent to continue geologic work north of the Porcupine in cooperation with the boundary survey parties. C. E. Ellsworth and R. W. Davenport were dispatched to continue stream gaging in the Yukon-Tanana region. In cooperation with the National Geographic Society, G. C. Martin undertook a study of the recent volcanic eruption in the Alaska Peninsula. H. M. Eakin left for the Ruby Creek district, in the Yukon basin, about the end of the fiscal year. No other surveys or investigations were possible before June 30.

#### OFFICE WORK.

During the year two professional papers (Nos. 69 and 70) and *six bulletins* (Nos. 448, 467, 480, 485, 500, and 504) relating to Alaska

have been issued. Three separates of parts of Bulletin 520 have also been published. Three bulletins (Nos. 498, 501, and 502) are in press. All these publications contain topographic maps. There have also been issued as sale publications two detailed topographic maps, those of Copper Mountain and vicinity and Kasaan Peninsula.

The following reports have been completed and illustrations for them are being prepared:

Coastal glaciers of Prince William Sound and Kenai Peninsula, by U. S. Grant and D. F. Higgins. (Bulletin 526.)

The surface water supply of Seward Peninsula, by F. F. Henshaw and G. L. Parker; with sketch of geography and geology, by P. S. Smith, and placer mining, by Alfred H. Brooks; including topographic reconnaissance map. (Water-Supply Paper 314.)

A geologic reconnaissance of the Fairbanks quadrangle, Alaska, by L. M. Prindle; with a detailed description of the Fairbanks district, by L. M. Prindle and F. J. Katz; including detailed and reconnaissance geologic and topographic maps. (Bulletin 525.)

In addition to these the following reports have been submitted during the year:

Geology of the Nome and Grand Central quadrangles, by F. H. Moffit; including detailed geologic and topographic maps.

The Hanagita-Bremner region, by F. H. Moffit; including reconnaissance geologic and topographic maps.

The Yentna district, by S. R. Capps; including reconnaissance geologic and topographic maps.

The Rampart quadrangle, by H. M. Eakin; including reconnaissance geologic and topographic maps.

The following reports are in hand:

Geology and ore deposits of Kasaan Peninsula and the Copper Mountain region, Prince of Wales Island, by C. W. Wright; including detailed geologic and topographic maps.

Geology of Glacier Bay and Lituya region, by F. E. Wright and C. W. Wright; including reconnaissance geologic maps.

Kenai Peninsula, by G. C. Martin, B. L. Johnson, and U. S. Grant; including reconnaissance geologic and topographic maps.

The Koyukuk-Chandalar gold region, by A. G. Maddren; including reconnaissance geologic and topographic maps.

The Iditarod-Innoko region, by A. G. Maddren; including reconnaissance geologic and topographic maps.

The Circle quadrangle, by L. M. Prindle, including reconnaissance geologic and topographic maps.

The Noatak-Kobuk region, by Phillip S. Smith; including reconnaissance geologic and topographic maps.

The following maps have been completed during the year and will be published as illustrations to reports:

Reconnaissance map of the Chitina quadrangle, by D. C. Witherspoon, T. G. Gerdine, and E. G. Hamilton; scale, 1:62,500; contour interval, 200 feet.

Reconnaissance map of the Koyukuk-Chandalar region, by T. G. Gerdine, D. C. Witherspoon, and A. G. Maddren; scale, 1:500,000; contour interval, 200 feet.

## GEOLOGIC RESULTS.

Mr. Moffit's investigations in the Bremner River region show that the series of sediments which have been assigned to the Valdez group include Carboniferous and Mesozoic rocks. In Kenai Peninsula Mr. Martin and Mr. Johnson have found that Jurassic rocks are included in the Sunrise group, heretofore regarded as chiefly Paleozoic. Mr. Brooks found two excellently defined systems of fissuring in the Port Valdez region, and similar systems were found by Mr. Johnson in the northern part of Kenai Peninsula, where Mr. Johnson also discovered a close connection between igneous intrusion and auriferous mineralization. A similar relation between intrusion and mineralization was noted by Mr. Capps in the Yentna placer district, where, too, Mr. Capps found a heavy series of Tertiary gravels resting conformably on Eocene coal measures. These Tertiary beds are in turn overlain by glacial deposits. This goes to show that the heavy gravel sheet of this district, formerly believed to have been deposited during the retreat of the ice, is of preglacial age.

In the Rampart region Mr. Eakin was able to segregate a series of Mesozoic sediments which had formerly been grouped with the Paleozoic. While mapping the Circle district Mr. Prindle found some Quaternary lavas and also evidence of a small amount of local glaciation. Mr. Maddren divided the rocks along the international boundary north of the Porcupine into four groups, as follows: (1) Quartzites, phyllites, and slates (pre-Ordovician); (2) heavy limestone, with some shale, sandstone, and chert (Carboniferous); (3) sandy and calcareous shales (Triassic); (4) quartzites and slates, with some conglomerates (Mesozoic?). There is also considerable granite (Mesozoic?) in this region.

In northwestern Alaska the facts of most general geologic interest contributed by the geologic survey of the Alatna-Noatak region made by P. S. Smith included the finding of small existing glaciers in the headwaters of Alatna and Noatak rivers, the collection of Carboniferous fossils from ledges at several places in the Noatak Valley, and the determination from fossils found in float that Triassic rocks occur within the Noatak basin.

## DIVISION OF MINERAL RESOURCES.

The scope of the work of the division of mineral resources during the fiscal year 1912 has been practically the same as that of the preceding year. The statistical work of the division was authorized by the act of August 7, 1882. The earlier reports contain chiefly statistical estimates prepared by experts on the subjects treated, together with more or less extended reviews of market conditions and of supply and demand, with special contributions on mining localities,

mining methods, and technical progress. During more recent years most of the chapters comprised in the reports have been prepared by geologists of the Survey who have specialized in the subjects treated by them, with a view to carrying out the provision of the organic act which directs the Geological Survey to classify the public lands and examine the geologic structure, mineral resources, and products of the national domain. This plan has brought eminently satisfactory results, in that it gives to the statistical work the benefit of the cooperation of the geologist trained in economic work and, on the other hand, gives to the geologist the opportunity to study the industrial and commercial conditions which affect the demand for the minerals. No less attention has been given to the statistical phase in these later years, but more comprehensive studies have been made of the sources of the mineral production and the application of the products in the useful arts. The volumes have in this way grown into a cyclopedia of information concerning the mineral resources of the United States. Knowledge of the storehouses from which the future supplies are to be drawn is considered to be of prime importance—of greater value, indeed, than the record of past mining achievement which is presented in the statistical compilations.

Recent volumes have contained general maps showing the areas producing coal, the precious and semiprecious metals, iron ore, petroleum, natural gas, cement materials, gypsum, salt, and various other minerals, with brief descriptive notes. The report for 1911 will contain maps showing the localities producing the different kinds of building stones in the Eastern States. These will be followed by similar maps showing the areal distribution of building materials. There is also in preparation a chapter on the useful minerals of the United States. This will contain brief descriptions of the minerals and the localities in which they occur and indicate whether or not they are at present mined or are still undeveloped.

The plan of cooperation between the Geological Survey and certain State surveys in collecting mineral statistics continued in force in connection with the report for 1911. The 18 States which cooperated were Alabama, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Michigan, Missouri, New Jersey, North Carolina, Oklahoma, Oregon, Pennsylvania, Texas, Virginia, Washington, and Wisconsin. As this cooperation becomes better appreciated, both by the Federal Survey and the State surveys, and is better understood by the producers, it works more and more smoothly. Its results in 1911 were the most satisfactory yet obtained. The plan obviates a duplication of a considerable amount of work and saves the producers the annoyance of preparing two sets of statistical reports.

During the fiscal year the work of the division consisted of the preparation of reports on the mineral production of the United States in the calendar years 1910 and 1911. The report for 1909, which had been delayed on account of the cooperative arrangement with the Bureau of the Census, was issued during the early part of the fiscal year 1911. The report for 1910 was published early in the calendar year 1912, and the work on the report for 1911 was well advanced at the close of the fiscal year. Thus work on three different reports on the mineral resources of the United States was carried on during the fiscal year 1912. Although the report for 1910 was not completed until early in the calendar year 1912, the separate chapters on all of the subjects except three were published during the calendar year 1911. The following table gives the estimated percentage of schedules returned at the close of the fiscal years (June 30) 1909, 1910, 1911, and 1912 for some of the more important products, the period covered by the returns being the preceding calendar year:

*Percentage of schedules returned from producers at the end of fiscal years 1909, 1910, 1911, and 1912.*

Industry.	1909	1910	1911	1912
Building stone.....	97	26	90	95
Clay working.....	98	35	95	100
Coal.....	98	26	99	100
Coke.....	100	15	100	100
Iron ore.....	100	24	100	100
Natural gas.....	90	43	80	95

Preliminary estimates of the production of coal, cement, copper, lead, zinc, gold, silver, petroleum, quicksilver, and tungsten in 1911, with reviews of the conditions which prevailed during the year, were given to the press in the form of special press bulletins late in December, 1911, and in January and February, 1912.

Advance statements giving the official figures covering the production of copper, lead, and zinc, in 1911, have also been published. Advance chapters from the report for 1911 on the following subjects (30 in all) have been published or are in press at the close of the fiscal year: Potash salts, asbestos, bauxite and aluminum, talc and soapstone, graphite, sulphur and pyrite, salt, monazite and zircon, iron-ore reserves of Michigan, sand-lime brick, mica, phosphate rock, fuller's earth, quicksilver, cement, abrasive materials, precious stones, gypsum, chromite, borax, magnesite, tin, salt and bromine, asphaltum, pottery, anthracite coal, fuel briquetting, gold and silver in the Eastern States, iron ore and pig iron, and manganese ores.

The number of employees in Washington who devote their entire time to the work of the division of mineral resources is 28, and 8 persons are employed in the offices of the division outside of Washington, at Salt Lake City, Denver, and San Francisco. In addi-

tion to these, 19 members of other divisions of the Survey, chiefly geologists, devote a portion of their time to the work of the division of mineral resources, making a total of 55 connected with this work.

During the year 164,490 pieces of first-class mail matter (chiefly statistical inquiries) were sent out by the division and 61,109 pieces were received.

Edward W. Parker continued as administrative head of the division, and Waldemar Lindgren exercised supervision over the preparation of chapters on metalliferous ores and a report on platinum. In addition to his administrative duties Mr. Parker prepared reports on the production of coal, the manufacture of coke, and the briquetting industry. E. S. Bastin was in charge of the preparation of the report on graphite; E. F. Burchard, cement, fluorspar and cryolite, glass sand, etc., gypsum, iron ore, lime, manganese, and stone; B. S. Butler, copper; A. T. Coons, slate; D. T. Day, asphalt and bituminous rock, natural gas, and petroleum; J. S. Diller, asbestos and talc and soapstone; J. P. Dunlop, lead and zinc in the Central States and secondary metals; H. S. Gale, borax, magnesite, and nitrates; F. L. Hess, antimony, arsenic, nickel and cobalt, etc., and tin; H. D. McCaskey, gold, silver, and copper in the Central and Eastern States and quicksilver; G. C. Matson, mineral waters; Jefferson Middleton, clay, clay-working industries, fuller's earth, quartz and feldspar, and sand-lime brick; W. C. Phalen, abrasive materials, barytes, bauxite and aluminum, chromite, mineral paints, potash salts, salt and bromine, sodium salts, strontium, and sulphur and pyrite; C. E. Sieben-thal, lead and zinc; D. B. Sterrett, gems and precious stones, mica, and monazite and zircon; W. T. Thom, summary of the mineral production; and F. B. Van Horn, phosphate rock. In addition to preparing his reports, Mr. McCaskey has exercised general supervision of the offices of the division in the Western States. These offices are under the direct charge of the following persons: Denver, C. W. Henderson; Salt Lake City, V. C. Heikes; San Francisco, C. G. Yale.

#### DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

During the fiscal year the chemical laboratory reported 388 quantitative analyses and 778 qualitative determinations, chiefly of minerals sent for examination by persons not connected with the Survey.

George F. Becker, the geologist in charge of the division, has been engaged chiefly in studying the effect of radioactivity on the cooling of the earth. He contrived a new device for determining the viscosity of liquids and spent some time in consultations on the effect of electrolytic action due to difference of potential of sulphides on the decomposition of ores. He also completed a paper showing that the formulas of "imaginary geometry" are applicable to the study of rock strains.



F. W. Clarke supervised the publication of the new edition of his "Data of geochemistry" (Bulletin 491) and also prepared a paper on geochemical statistics.

George Steiger was occupied with routine quantitative analyses and experimental work to show the exact conditions to be observed in the colorimetric determination of manganese.

Chase Palmer made a number of analyses of rocks and minerals and did research work on a selenide mineral containing gold. His paper entitled "The geochemical interpretation of water analyses" was published as Bulletin 479.

R. C. Wells analyzed some rocks from the Canal Zone and other localities and did research work on the fractional precipitation of silicates and hydroxides.

W. T. Schaller made numerous chemical and mineralogical determinations and quantitative rock analyses, including the description of several new mineral species. His "Mineralogical notes," series 1 and 2, were published as Bulletins 490 and 509 of the Survey. Mr. Schaller resigned from the Survey March 31 for the purpose of studying abroad, and Walter F. Hunt, of Ann Arbor, Mich., was appointed to fill temporarily the vacancy caused by his resignation.

J. G. Fairchild analyzed phosphate rocks, limestones, and some minerals and also elaborated and published a method for determining phosphoric acid in phosphate rock.

The work in the physical laboratory, under the direction of C. E. Van Orstrand, has continued along the same lines as heretofore, except that the experiments on elasticity and plasticity have been discontinued temporarily pending the appointment of an assistant. The experiments on the diffusion of solids have been continued throughout the year, and the scope of the investigation has been extended to include a study of the variation of diffusion with both pressure and temperature. Two mathematical tables have been completed. The first consists of sixteen hundred 18-place values of the circular sine and cosine, and the second consists of twenty-five hundred 10-place values of the inverse gudermannian, each to radian argument. A table of the ascending exponential has been begun. A portion of the table on the probability integral will be ready for publication in a few months.

#### **LAND-CLASSIFICATION BOARD.**

##### **ORGANIZATION.**

The land-classification board began the fiscal year 1911-12 with the organization and the personnel of the preceding fiscal year. Changes have since been effected through reorganization, resignations, and new appointments, so that at the end of the year the board, now a definitely organized branch of the Geological Survey,



has a staff of 30 permanent employees. Of this number 12 are professional workers, either geologists or engineers of the various grades, 4 are technical, and 14 are clerical or subclerical. In addition to these, temporary or occasional service has been rendered by about 22 others, of whom 14 are geologists and engineers of the field branches who either have been assigned to the board for short periods or have acted in an advisory capacity as members of the various classification sections. The remaining nonpermanent employees have held technical or clerical appointments.

Much the most important change of the year was that effected by the Director's order of May 1, 1912, by which the status of the board was changed from that of a section in the geologic branch to an independent branch coordinate in responsibilities and functions with the geologic, topographic, and water-resources branches. The new branch, retaining its old name, land-classification board, includes two divisions—that of mineral classification and that of hydrographic classification—and each of these divisions contains a group of sections dealing directly with a particular resource or a particular problem. The branch is organized as follows:

*Land-classification board.*

*Administration.*

W. C. Mendenhall, chief of board.

N. C. Grover, chief engineer.

Elsie Patterson, secretary.

*Division of mineral classification.*

W. C. Mendenhall, geologist in charge.

Coal section—George H. Ashley, chairman.

Oil section—M. W. Ball, chairman.

Phosphate section—A. R. Schultz, chairman.

Metalliferous section—A. R. Schultz, chairman.

*Division of hydrographic classification.*

N. C. Grover, chief engineer in charge.

Water-power section—W. B. Heroy, chairman.

Irrigation section—Herman Stabler, chairman.

The reorganization made a definite change in the relations of the board to the field branches of the Survey. The order creating the new branch defined its duties as the consideration of questions of Survey policy in matters relating to land classification and the preparation of reports thereon to the Director, and the receiving from other branches and the recording of all data valuable in the administration of the public lands. In the fulfillment of these functions the board prepares all letters or papers relating to the classification of the public lands and the administration of the public domain.

The most important changes in the staff have been the appointment of A. R. Schultz, assistant geologist, as chairman of the phosphate section on August 16, 1911; the resignation of W. R. Calvert, effective on April 1, 1912; and the appointment of George H. Ashley to take the place made vacant by Mr. Calvert's resignation.

Mr. Schultz was at first placed in charge of the phosphate work of the board, which had fallen greatly in arrears because of the inadequacy of the force, and later his authority was extended to include the work of the section on metalliferous deposits.

Mr. Ashley, State geologist of Tennessee for two years prior to his reappointment on the Geological Survey as a member of the land-classification board, replaced Mr. Calvert as chairman of the coal section.

#### SPECIAL FEATURES.

The work of the board during the last year has in general followed the lines along which its activities have been exercised during the two preceding years. There has been increase in the volume rather than change in the type of work. Orders from the Secretary of the Interior, however, have resulted in some expansion other than that in volume merely. On January 11 and 18 orders were issued that all entries and selections which are not specifically excepted from reservation under the act of June 25, 1910 (36 Stat., 847), and under which a vested right has not accrued should be submitted to the Geological Survey by the Commissioner of the General Land Office for report as to any mineral or power values involved. Under these and earlier orders and cooperative agreements, approximately 12,000 cases of various types, including right-of-way applications and enlarged-homestead petitions, were referred to the Geological Survey during the fiscal year and action was taken on about 10,000 of these. In the special-agent cases and the requests for information from the General Land Office and the Indian Office, which form a very large percentage of the total referred cases, the mineral or power values of the lands are chiefly involved, and in all cases where the Survey's records showed that the lands were nonmineral and had no power or reservoir values the General Land Office was saved the necessity of field examinations.

The value to the department of the orders of January 11 and 18, 1912, is indicated in the fact that in only 292 of the 2,844 cases reported upon by the Survey under these orders since March 1 has it been necessary to recommend examination in the field by the agents of the General Land Office. The time and expense of making such field examinations were saved in the great majority of the remaining 2,552 cases, and even if this represents a higher percentage than will be maintained on the average, the result is a marked saving to the *department as a whole* and indicates a distinct advance in efficiency.

*Action taken on requests for information under cooperative agreement of March 5, 1912.*

State.	Re- ceived.	Acted on.						Pend- ing.
		Min- eral.	Non- min- eral.	Field exam- ination recom- mended (min- eral).	Power.	Non- power.	Field exam- ination recom- mended (pow- er).	
Alabama.....	7			6		6	6	1
Alaska.....	71	1	63		2	23	65	6
Arizona.....	110		38		2	45	47	63
Arkansas.....	5	0	0	0	0	0	0	5
California.....	301	4	80	63	2	209	5	74
Colorado.....	83	3	27	0	1	58	0	19
Florida.....	31	0	2	0	0	29	0	2
Idaho.....	308	0	72	27	0	131	0	176
Kansas.....	3	0	2	0	0	2	0	1
Louisiana.....	15	0	1	0	0	1	0	14
Michigan.....	1	0	1	0	0	1	0	
Minnesota.....	77	0	10	0	0	17	0	53
Mississippi.....	1	0	0	0	0	0	0	1
Montana.....	840	0	177	35	4	366	0	469
Nebraska.....	15	0	14	0	0	14	0	1
Nevada.....	97	0	0	1	0	3	0	94
New Mexico.....	712	1	27	5	0	461	0	250
North Dakota.....	69	0	8	0	0	44	0	25
Oregon.....	409	1	24	38	7	308	1	91
South Dakota.....	8	1	3	0	0	3	0	4
Utah.....	410	6	5	0	2	154	0	253
Washington.....	382	0	17	19	19	267	0	95
Wisconsin.....	9	0	2	0	0	2	0	7
Wyoming.....	871	44	384	92	3	579	1	287
	<sup>a</sup> 4,835	61	957	286	42	2,723	7	<sup>b</sup> 1,991

<sup>a</sup> A large number of these cases were received prior to the adoption of the cooperative agreement of Mar. 5, 1912.

<sup>b</sup> Certain of these cases are accompanied by reports as to mineral character and are included as mineral cases in the table below, showing the action taken on reports by Land Office field agents during the year

The table below shows the action taken on reports on the mineral or power value of lands rendered by Land Office field agents during the year and submitted to the Survey for a recommendation of appropriate action.

*Work of Land Office field service showing mineral character and power-site and reservoir possibilities of lands.*

State.	Pending July 1, 1911.	Received July 1, 1911, to June 30, 1912.	Acted on.			Total acted on.	Pending July 1, 1912.
			Ap- proved.	Part ap- proved.	Disap- proved.		
Arizona.....		18	13			13	5
Arkansas.....		1			1	1	
California.....	18	163	93	1	23	117	64
Colorado.....	40	171	144	1	39	184	27
Florida.....	3	3	2		3	5	1
Idaho.....	14	163	120	4	41	165	12
Louisiana.....	10	32	41		1	42	
Minnesota.....		24					24
Montana.....	57	529	456	9	87	552	34
Nevada.....	0	42	30		1	31	11
New Mexico.....	1	487	231	2	3	236	252
North Dakota.....	5	179	102		10	112	72
Oregon.....	54	679	589	4	8	601	132
South Dakota.....							
Utah.....	116	451	453	2	11	466	101
Washington.....	3	275	218	3	20	241	37
Wyoming.....	39	149	157	2	12	171	17
	360	3,366	2,649	28	260	2,937	789

In addition to the cases shown in the foregoing table, the Land Office, in compliance with departmental order of April 27, 1911, has requested information as to power-site value in 188 cases involving lands recommended for elimination from national forests or included in restorations of administrative sites, of which number 164 were received during the fiscal year. The Survey has complied with 172 of these requests, and 16 are pending at the end of the fiscal year.

Work has continued throughout the year under the departmental order of March 27, 1911, requiring a report by the Geological Survey as to the mineral character and power or reservoir value of lands included in tribal allotments or proposed town sites on Indian lands. By order of the First Assistant Secretary of August 23, 1911, the preparation of these reports has been made special, although this preference has at times necessitated the neglect of other work. The Indian Office has forwarded 4,876 such requests for data during the year. The Survey has furnished information in 3,385 cases, and 1,494 cases are now pending.

Another feature of the work of the year that is of special interest was the establishment of a new type of reserve by recommending to the department the withdrawal from entry, by presidential action, of certain lands in the arid West that are known to be valuable in protecting the public range, because of the water supplies on them. Only three desert water reserves of this type have thus far been created. because the energies of the board have been so largely absorbed by its regular work that it could give but little attention to this feature. The information available in the Survey, however, is gradually being assembled, and as a result the creation of other reserves will be recommended to the Secretary during the fiscal year 1912-13.

By direction of the Secretary of the Interior an attempt has been made, in cooperation with officials of the Forest Service, to devise regulations for water-power development under the act of February 15, 1901 (31 Stat., 790), which shall provide for uniform administration by the departments of the Interior and of Agriculture on the public lands and the national forests. A draft of proposed regulations prepared in conference with the Forest Service was informally transmitted to the office of the Secretary of the Interior.

In connection with its work under the Carey Act the Geological Survey has continued to render to the Secretary, through the Commissioner of the General Land Office, full and detailed reports on the water supply available, the duty of water, the control of lands, the feasibility of the structures involved and of the project as a whole, and the protection afforded to the settlers under the contract with the State. It has urged that the investigation of these matters shall be much more thorough than in the past in order that the interests of settlers on Carey Act projects may be fully safeguarded.

To this end it has drafted and recommended to the Secretary for adoption detailed changes in the regulations governing the presentation by the States of applications for the segregation of lands under that act.

In the matter of internal organization and procedure there has been an endeavor to simplify and systematize the work of the Board, to the end that the available force might become more efficient and with a given expenditure of energy might produce a larger and more accurate output. Among the devices adopted for this purpose have been certain types of form letters, to be used in the simpler Land Office and Indian Office cases, and a series of "safety maps," prepared for each of the public-land States, to facilitate answers to inquiries as to mineral or power values. Two groups of these maps are in course of preparation—one by the division of mineral classification and the other by the division of hydrographic classification. On maps in the first group all areas known or suspected to contain mineral deposits of any type are colored in accordance with a definite plan. The remaining white areas may thereafter be automatically clear-listed as to mineral values. Similarly in the division of hydrographic classification maps have been prepared on which all areas known or suspected to contain reservoir sites or lands valuable for power development are appropriately colored. Thereafter the lands remaining white on these maps may be automatically clear-listed without special search of the records and the literature.

#### DIVISION OF MINERAL CLASSIFICATION.

The division of mineral classification receives from the geologic branch the results of the field work of its force and prepares from them the official classifications of mineral lands. Its work deals primarily with the classes of deposits whose reservation from entry is authorized by the withdrawal act (36 Stat., 847), namely, coal, oil and gas, and phosphate, but it also passes on the character of lands applied for under the nonmineral-land laws. An important special case of the latter type arising during the past year has been the classification of Northern Pacific Railroad grant lands under the act of February 26, 1895 (28 Stat., 683).

#### COAL.

The fiscal year 1911-12 has been notable, as regards the classification of coal lands, principally in that for the first time the lands classified and restored have much exceeded in area those withdrawn for classification, so that at the end of the year there was a substantial reduction in the area of land withdrawn. Heretofore, though the examinations have resulted in an increase in the area classified and restored each year and so have subtracted from the area with-

drawn, new information has led to the withdrawal of additional lands whose area has far exceeded that of the lands restored. Although no prediction on this point can be made with absolute certainty, it is probable that the area of withdrawn lands will continue to be decreased.

*Classifications.*—During the fiscal year 847,601 acres were classified as coal land and valued at \$14,751,472 and 13,794,262 acres were classified as noncoal land. A large part of the area classified as coal land was in the region of low-grade coals of North Dakota, South Dakota, and eastern Montana, where the appraised values under the regulations are the minimum fixed by law. Other large areas that are known to contain some coal have been withdrawn pending classification, and much of this land has been examined, classified, and restored to entry. Examination of some of these areas has revealed considerable land containing workable coal and work on other areas has shown that the workable coal is of small amount, so that much of the land withdrawn could be restored as noncoal as a result of relatively rapid work. On the other hand, the field work in areas containing thick and high-grade coals has been done with greater detail and care, covering smaller areas than in previous years, so that the total value of coal lands priced is not large as compared with the total value of lands priced in earlier years. No small part of the work has been the classification of lands in the Indian reservations that were to be thrown open to settlement. The following table shows the progress of coal-land classification by States during the year:

*Coal land classified during the year ended June 30, 1912.*

*a Reductions during the year from former classification under old regulations, comprising lands either rewithdrawn or reclassified under new regulations.*



The sale of coal lands at the new figures has continued at a moderate rate during the last year as during the years immediately preceding. In all, 7,951.05 acres were sold, for \$402,521.78, an average price of \$50.62 an acre. These sales indicate that the suggestion once made that coal lands would not sell at the new figures was not well founded. Indeed, with the increasing detail with which the work in the field is being done there is a growing tendency to accept the Survey's appraisal as a fair indication of the value of the lands classified by it. The increase in the coal production of the Rocky Mountain States during the last few years indicates that the coal industry of that region has not been injured, as it was feared by some it might be. Further, a comparison of the sales of coal land for the five years preceding and following the adoption of the classification policy shows a gain in the receipts from the sale of coal lands, with a slight decrease in the acreage sold. The following table shows the relations of the sales for the two five-year periods immediately preceding and following July 1, 1907:

*Sales of coal land at all prices in the United States, exclusive of Alaska, from 1902 to 1911.*

**Five years prior to July 1, 1907.**

Fiscal year	Entries.	Acres.	Receipts.	Average price per acre.
1902-3.....	252	38,007.88	\$498,997.00	\$13.13
1903-4.....	190	28,827.42	395,209.90	13.74
1904-5.....	158	20,456.35	277,402.40	13.56
1905-6.....	244	42,143.39	538,683.70	12.54
1906-7.....	157	20,387.02	303,255.60	14.80
	1,001	149,822.06	2,013,548.60	13.44

**Five years since July 1, 1907.**

1907-8.....	209	58,047.10	\$647,584.55	\$11.15
1908-9.....	182	26,590.68	502,743.65	18.90
1909-10.....	189	26,074.16	657,175.80	25.20
1910-11.....	83	15,284.89	251,323.03	16.44
1911-12.....	76	7,951.05	402,521.78	50.62
	829	133,947.88	2,461,348.81	18.30

Under the regulations now in force a large share of the coal land will continue to be classified at the minimum price. Practically all the land in the Dakotas is being so priced, and much of that in Montana, besides a considerable percentage of the land classified in other States, so that purchases will continue to be made mainly at the minimum prices. As indicating that the higher-priced coal lands also sell, notwithstanding the higher prices, the following table is given, showing the prices at which coal lands have been sold, the num-

ber of entries at the different prices, the acres sold at those prices, and the receipts:

Sales of coal lands at various rates since July 1, 1907.

Price per acre.	Entries to date.	Acres.	Receipts.	Price per acre.	Entries to date.	Acres.	Receipts.
\$10.00	352	50,067.25	\$501,553.13	\$100.00	1	38.48	3,848.00
12.50	1	56.03	700.38	120.00	1	40	4,800.00
14.50	1	40	580.00	130.00	1	38.54	5,010.20
15.00	16	2,470.55	37,058.25	135.00	1	80	10,800.00
17.50	1	40	700.00	140.00	1	120	16,800.00
20.00	276	54,655.65	809,481.20	145.00	1	40	5,800.00
25.00	41	11,691.68	144,671.70	155.00	1	40	6,200.00
30.00	25	3,239.81	97,194.30	170.00	1	39.89	6,781.30
33.00	1	40	1,320.00	180.00	1	40	7,200.00
35.00	2	239.78	8,392.30	270.00	1	39.79	10,743.30
36.00	1	40	1,440.00	370.00	1	41.40	15,318.00
40.00	9	840.72	33,628.80	375.00	1	41.73	15,648.75
45.00	1	280	12,600.00	385.00	2	83.14	32,008.90
49.00	1	40	1,960.00	390.00	1	41.64	16,239.60
50.00	70	8,338.63	415,023.00	395.00	2	124.63	49,228.85
65.00	-----	200	13,000.00	400.00	2	83.15	33,260.00
70.00	1	40.79	2,855.30	405.00	3	166.51	67,436.55
75.00	2	161.23	12,092.25	410.00	2	83.39	34,189.90
90.00	2	204.96	18,446.40				
92.00	1	40	3,680.00		829	133,947.88	2,461,348.81
95.00	1	38.51	3,658.45				

*Withdrawals and restorations.*—As predicted in the report on this subject for 1911, the area of lands withdrawn during the fiscal year 1911–12 has been small as compared with that withdrawn during preceding years and for the first time has been less than the area classified and restored, so that at the end of the year there is a considerable net decrease in the area withdrawn over that withdrawn on June 30, 1911. Of the withdrawals made during 1911–12 that in Colorado, in the Denver Basin, involves only a relatively small amount of public land. The continued striking of workable coal in water wells in this area made it seem desirable to withdraw all the public land in the basin.

Coal lands withdrawn during the fiscal year 1911–12.

State.	Outstanding July 1, 1911.	New with- drawals dur- ing fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1912.
	Acres.	Acres.	Acres.	Acres.
Arizona.....	118,718	.....	.....	118,718
California.....	239,903	.....	.....	239,903
Colorado.....	5,517,338	3,004,889	277,164	8,245,063
Idaho.....	6,985,417	11,520	5,430,019	1,566,918
Montana.....	19,890,471	20,189	2,268,369	17,642,291
Nevada.....	92,141	.....	.....	92,141
New Mexico.....	5,809,490	.....	59,050	5,750,440
North Dakota.....	18,454,490	.....	80	18,454,410
Oregon.....	3,521	.....	.....	3,521
South Dakota.....	2,375,263	.....	1,508,454	866,809
Utah.....	6,221,314	654,834	511,365	6,364,783
Washington.....	2,210,807	41,745	46,362	2,206,190
Wyoming.....	7,013,543	19,716	368,957	6,654,302
	74,932,416	3,752,893	10,409,820	68,215,489

*Application for classification.*—Increased understanding of the operation and effect of the act of June 22, 1910, is resulting in a decrease in the number of applications for the classification of lands included in coal withdrawals. A few entrymen, however, because entries under that act can not be commuted or because of other requirements or restrictions, object to patents reserving coal to the United States and therefore file applications to have lands classified as noncoal. Most of the affidavits by which such applications are supported are valueless, and therefore few such requests can be granted, since the withdrawals are made for the purpose of retaining title to the coal in the Government until information adequate for classification is obtained. The following table shows the action taken on cases of this class since the passage of the act under which they are made.

*Applications for classification of withdrawn coal lands.*

Year.	Received.	Approved.	Denied.	Pending.
1910-11.....	46	4	36	6
1911-12.....	18	1	22	1
	64	5	58	1

*Applications for reclassification.*—In order to guard against possible errors in classification, whereby injustice might be done, provision is made for applications for reclassification. Any person desiring to enter or select, under the agricultural laws, lands classified as coal lands may submit an application for reclassification, supporting it by affidavits setting forth the evidence which seems to him to show that the existing classification is erroneous. As a rule, the affidavits thus submitted are of the most perfunctory sort and are barren of facts affecting the classification. Now and then, however, an application is accompanied by valuable information, to which most careful consideration is given, and when this information shows the previous classification to be in error a reclassification is made.

There is a notable decrease in these applications from year to year, also due, doubtless, to the fact that the act of June 22, 1910 (36 Stat., 583), provides for homestead and desert-land entries on coal lands with a reservation of the coal to the United States. During the fiscal year following the passage of the act (1910-11) the number of applications was only a little over one-third that of the preceding year. The number received during the year 1911-12 is only a little over one-half that received during 1910-11, showing that the entryman who looked upon a reservation of coal to the Government as a cloud on the title is coming to realize that a restricted patent with the safeguards provided by the act referred to is not *in any sense* clouded. That the passage of the act of April 30, 1912,

extending the provisions of the act of June 22, 1910, to State selections, soldiers' additional homesteads, and isolated tract sales will result in a still further decrease in the number of applications for reclassification is indicated by the fact that of the 26 applications received during the year 7 were made in a single State. The following table shows the action on these applications since they first began to be received:

*Applications for reclassification of coal lands.*

Year.	Received.	Ap- proved.	Part approved.	Denied.	Pending.
1909-10.....	128	3	3	116	4
1910-11.....	48	0	0	21	<sup>a</sup> 29
1911-12.....	29	0	0	53	<sup>b</sup> 4
	203	3	3	190	4

<sup>a</sup> One case canceled by relinquishment and one returned to entryman.

<sup>b</sup> One case recalled by General Land Office.

#### OIL.

No legislation providing for the disposition of oil and gas in the public domain has been enacted during the year, and these minerals must be acquired, if at all, under the wholly unsatisfactory placer law, which adequately protects neither the Government nor the oil operator. In order to retain in public ownership all lands that are probably oil-bearing, pending the passage of a satisfactory oil and gas law, the withdrawn area has been increased during the year by 803,753 acres. A relatively small area in the West Side fields of California was withdrawn because of recent developments showing that the productive territory extends farther under the San Joaquin Valley than had at first been supposed. A withdrawal was made of over a million and a quarter acres in a little-known region in east-central Utah, which is indicated as a result of a preliminary examination by Survey geologists to be favorable for oil accumulation. Restorations were made of areas in California, New Mexico, and Wyoming, which were found not to be valuable for oil or gas. The following table shows the action during the year, by States:

*Summary of withdrawals of oil lands, fiscal year 1911-12, in acres.*

State.	Outstand- ing July 1, 1911.	New with- drawals.	Restora- tions.	Outstand- ing June 30, 1912.
Arizona.....	230,400	.....	.....	230,400
California.....	1,592,704	23,947	640	1,616,011
Colorado.....	87,474	.....	.....	87,474
Louisiana.....	414,720	.....	.....	414,720
New Mexico.....	419,901	.....	419,901	0
Oregon.....	74,849	.....	.....	74,849
Utah.....	581,566	1,370,760	.....	1,952,326
Wyoming.....	568,815	.....	170,413	398,402
Total.....	3,970,429	1,394,707	590,954	4,774,182

## PHOSPHATE.

The examination of phosphate deposits in the Rocky Mountain region was begun by the United States Geological Survey in 1909 and has been continued every year since that time. During the summer of 1911 deposits of phosphate rock similar in character to the deposits of eastern Idaho, and at the same geologic horizon, were discovered in west-central Montana, in the vicinity of Garrison, Elliston, and Philipsburg, by United States Geological Survey parties making examinations of Northern Pacific Railway lands. These discoveries proved that valuable phosphate beds extend much farther north and are distributed over a much wider territory than had formerly been supposed.

The phosphate discoveries made in examining the Northern Pacific lands, together with the phosphate examinations in eastern Idaho and western Wyoming, show that considerable areas now known to contain phosphate deposits were not included in the phosphate withdrawals. In order to protect these newly discovered phosphate beds and reserve them for future use pending the enactment of appropriate legislation for their disposition, all public lands containing valuable phosphate beds not included in existing phosphate reserves were withdrawn from entry. Any lands in a phosphate reserve that were examined and found to contain no phosphate deposits were restored to agricultural entry. Withdrawals and restorations have been made to cover all the phosphate lands examined in the summer of 1911, except those examined in western Wyoming, in the vicinity of the Gros Ventre Mountains. As soon as the data obtained in the examination are assembled the limits of the phosphate reserve in this region will be so modified as to include only lands shown by the examination to contain phosphate.

The year 1911-12 has been very productive as regards the examination of phosphate land. The area examined in detail and in a reconnaissance way, together with the area examined in connection with the Northern Pacific grant lands, greatly extended the knowledge of the western phosphate field. The field examinations this year, as in previous years, have materially increased the area withdrawn, so that at the end of the year the area covered by outstanding withdrawals is nearly a million acres more than a year ago. The field examinations each year have increased the area restored to agricultural entry and subtracted from the outstanding withdrawals all areas found to contain no phosphate. New information gathered each year has led to the withdrawal of additional lands not previously known to contain phosphate beds, and thus far the withdrawn lands far exceed the restored lands in area. As further field examinations are made the results will likely be reversed, and the restoration will exceed the withdrawals as soon as most of the

phosphate land is included within the reserves, and thereafter field examinations will continue to cut down the area of the outstanding withdrawals.

Phosphate deposits must be acquired, if at all, under the present mining laws applicable to lode or placer claims, neither of which is satisfactory for the disposition of the stratified sedimentary phosphate beds. A number of measures, including a bill providing for "the acquiring of title to public lands classified as and carrying phosphate deposits," similar in tenor to the act of March 3, 1909, providing "for the protection of the surface rights of entrymen on coal land," were introduced during the second session of the Sixty-second Congress, but thus far none has become law.

During the year the regulations governing the withdrawals and restorations of phosphate lands have been so modified as to exclude from the phosphate reserves all deposits that do not contain phosphate in sufficient quantities to warrant holding them for this mineral. All sandstones, shales, and limestones containing less than 30 per cent of tricalcium phosphate are not considered phosphate deposits. Phosphate beds that are 6 feet or more thick and that contain 70 per cent or more of tricalcium phosphate are reserved to a depth of 5,000 feet; thinner and low-grade phosphate beds are held to depths ranging from the maximum of 5,000 feet to a minimum of zero at the surface.

The area withdrawn as a result of the examinations made in Montana comprises 240,911 acres. Detailed and reconnaissance examinations made in Idaho resulted in withdrawing 354,717 acres of phosphate land and restoring 349,049 acres to agricultural entry. As a result of the Survey's reconnaissance examinations in Wyoming, 826 acres were restored to entry and 597,591 acres were withdrawn pending detailed examination. In Florida 2,199 acres were restored to entry. A summary of the outstanding withdrawals follows.

*Withdrawals of phosphate lands, fiscal year 1911-12, in acres.*

State.	Outstanding July 1, 1911.	New withdrawals.	Restorations.	Outstanding June 30, 1912.
Florida.....	37,839	.....	2,199	35,640
Idaho.....	952,388	354,717	249,049	1,058,056
Montana.....	33,950	240,911	.....	274,861
Utah.....	107,745	.....	.....	107,745
Wyoming.....	1,267,494	597,591	826	1,864,259
	2,399,416	1,193,219	252,074	3,340,561

#### METALLIFEROUS DEPOSITS.

Under the act of February 26, 1895 (28 Stat., 683), provision was made for classifying, with regard to their mineral or nonmineral character, the lands within the Northern Pacific Railroad grant in



Montana and Idaho. The classification proved unsatisfactory for many areas and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 703). At the request of the General Land Office the reclassification was made by the Survey. The field examination of these lands was undertaken by the Survey during the field season of 1910, when 176,031 acres were classified as mineral and 112,434 acres as nonmineral. During the summer of 1911 three parties continued examinations of the Northern Pacific grant lands and succeeded in examining all the remaining tracts except a small number of parcels in Tps. 44 and 45 N., R. 9 E., and a few scattered tracts not listed to the Survey until after the close of the field season. A few of the Northern Pacific tracts not listed by the General Land Office until after the close of the field season were examined in the course of the work, as they lay adjacent to some of the lands investigated. The results of the classification work for the two years are shown in the following table:

*Lands in Northern Pacific Railroad grant in Montana and Idaho classified by United States Geological Survey.*

[Areas in acres.]

	Classified prior to July 1, 1911.	Classified during fiscal year 1911-12.	Classified June 30, 1912.
Mineral.....	176,031	20,278	196,309
Nonmineral.....	112,514	137,036	249,550
	288,545	157,314	445,859

Examinations of lands within the Blackfeet and Flathead Indian reservations, Mont., have also been made for the Indian Office by the Survey, in order to separate mineral from nonmineral lands as a basis for sales and allotments.

#### DIVISION OF HYDROGRAPHIC CLASSIFICATION.

The division of hydrographic classification considers reports on field examinations involving water supply and water utilization on the public lands and prepares classifications and correspondence based thereon. The scope and the amount of this work are fully set forth in the following paragraphs.

#### WATER POWER.

*Withdrawals and restorations.*—The classification of the public lands with relation to their value in connection with water power was continued during the year, the withdrawals being made under the authority conferred by an act of June 25, 1910 (36 Stat., 847), and sections 13 and 14 of another act of June 25, 1910 (36 Stat., 858, 859). On July 1, 1911, the area included in outstanding withdrawals was 1,515,423 acres. During the year, as a result of additional informa-



tion largely secured through field investigations by the topographic and water-resources branches, 353,444 acres additional were withdrawn and 55,114 acres previously included in power-site reserves were determined to be without sufficient value to warrant the continuance of the withdrawal and were restored to the public domain. The total area withdrawn in connection with water powers on June 30, 1912, was 1,813,753 acres.

The following table shows the action taken during the last year and the areas outstanding, classified by States:

*Power-site reserves, fiscal year 1911-12.*

State.	Outstanding July 1, 1911.	New with- drawals dur- ing fiscal year.	Restorations during fiscal year.	Outstanding June 30, 1912.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Arizona.....	213,390	3,019	23,448	192,961
California.....	53,689	115,383	4,064	165,008
Colorado.....	209,174	39,278	3,799	244,653
Idaho.....	229,692	72,432	6,667	295,457
Minnesota.....	8,388	2,866	.....	11,254
Montana.....	127,687	31,097	7,678	151,106
Nevada.....	15,375	.....	80	15,295
New Mexico.....	9,706	4,830	.....	14,536
Oregon.....	161,795	24,367	1,919	184,243
Utah.....	347,252	27,778	.....	375,030
Washington.....	80,386	29,734	6,979	103,141
Wyoming.....	58,889	2,660	480	61,069
	1,515,423	353,444	55,114	1,813,753

*Applications for reclassification.*—Thirty-two applications for the reclassification of lands included in power-site reserves have been filed by persons desirous of acquiring title to public lands so withdrawn. In 13 cases the lands desired were released from withdrawal because the lands were shown on investigation not to be valuable for power purposes. Fifteen applications were refused because of the power value of the lands requested.

*Right-of-way applications.*—The water-power possibilities involved or affected by applications for rights of way for railroads, irrigation canals and reservoirs, and water-power developments have been, as heretofore, reported upon by the Geological Survey.

During the fiscal year 600 applications were received and 798 were reported upon, so that 128 applications were pending report at the close of the year, as compared with 326 at the close of the preceding fiscal year. The character of the applications received and the action taken thereon are shown in the following table:

*Applications for rights of way.*

	Railroad.	Irrigation.	Water- power.	Miscella- neous.	Total.
Pending July 1, 1911.....	110	183	22	11	326
Received July 1, 1911, to June 30, 1912.....	132	399	29	40	600
Acted on July 1, 1911, to June 30, 1912.....	198	512	44	44	798
Pending June 30, 1912.....	44	70	7	7	128

IRRIGATION.

*Reservoir withdrawals.*—In addition to withdrawals of lands which appear to be primarily valuable in connection with water-power development, a number of reservoir sites, principally valuable for irrigation storage, have been surveyed by the Geological Survey and the lands included therein withdrawn from entry under the two withdrawal acts.

The area included in such withdrawals at the close of this fiscal year is shown in the following table:

*Reservoir-site withdrawals.*

State.	Outstand- ing July 1, 1911.	New with- drawals during fiscal year.	Restora- tions dur- ing fiscal year.	Outstand- ing June 30, 1912.
Arizona.....		23,040		23,040
Montana.....		15,640		15,640
North Dakota.....	1,091	478		1,569
Oregon.....	16,884			16,884
South Dakota.....		8,542		8,542
Washington.....	18,553	13,000		31,553
	36,528	60,700		97,228

*Carey Act segregations.*—During the year 31 applications for the segregation of lands under the Carey Act have been considered by the board, including five applications pending at the beginning of the fiscal year and seven resubmitted cases on which report had previously been made. These lists were referred to the Survey for report on the water supply available, the general feasibility of the projects, and the mineral or nonmineral character of the lands. Eight of the lists were recommended for approval, and the remaining 22 were reported as having insufficient water supply or inadequate plans of irrigation. In only three cases were the conditions such that the rejection of the applications was recommended. In general, attention was called to the defects in the project as presented, and recommendations were made that the State be allowed to amend, by decrease of area to be irrigated, by increase of storage capacity, or by such other means as appeared to be necessary to make the development reasonably safe, not only to the developing company but also to the investors in the bonds and to the settlers on the land. One list was awaiting report at the end of the year.

*Irrigation projects.*—In addition to determining power possibilities affected, the board reports on right-of-way applications filed in connection with irrigation projects, stating the general character and feasibility of the project and the control of the lands irrigable thereunder in the interest of the project. The purpose of such investigations is to effect the proper utilization of the water resources of the public lands and to prevent the title to public lands becoming

clouded by easements which are sought for canals and reservoirs that are not feasible of construction or which are filed for purely speculative purposes.

**ENLARGED HOMESTEADS.**

The scope of the act of February 19, 1909 (35 Stat., 639), commonly known as the enlarged-homestead act, was broadened by the act of June 13, 1912 (Public, No. 191), by the extension of its general provisions to the States of North Dakota and California. Classification of lands in the other 10 States to which the acts apply has proceeded along the lines previously followed. The area designated has, however, been much smaller than in previous years, owing primarily to the fact that the great bulk of the nonirrigable lands had already been opened to entry. The problems arising in connection with the designations are becoming increasingly complex and the reaching of a proper decision as to the character of lands frequently requires exhaustive field examination.

Designations under the general provisions of the act rest primarily upon the determination of the fact that the lands are "not susceptible of successful irrigation at a reasonable cost from any known source of water supply," although the arability of the lands, climatic conditions, and forest cover are also taken into consideration. The information upon which recommendations are based is obtained through field investigations by engineers and geologists of the Geological Survey and, in part, from reports of special agents of the General Land Office. Both the surface and the underground water supply available are considered in making these determinations.

The nonresidence provisions, applicable to the States of Utah and Idaho, require additional investigation to determine whether or not the lands "have upon them such a sufficient supply of water suitable for domestic purposes as would make continuous residence upon the lands possible." In this work not only are the quantity and quality of surface waters investigated, but the possibility of obtaining water for domestic purposes from wells is also considered.

The work of the fiscal year is summarized in the following table:

*Summary of enlarged-homestead designations.*

State.	Outstanding July 1, 1911.	New designa- tions during fiscal year.	Cancellations during fiscal year.	Outstanding June 30, 1912.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Arizona.....	26, 589, 917	389, 320	19, 458	26, 959, 779
Colorado.....	20, 354, 509	11, 027	.....	20, 365, 536
Idaho:				
Sections 1-5 only.....	5, 336, 838	91, 731	3, 941	5, 424, 628
Section 6.....	3, 841	5, 723	a 1, 763	7, 801
	5, 340, 679	97, 454	5, 704	5, 432, 429

a Cancellation of designation under sec. 6, approved Mar. 2, 1912; acreage transferred to sec. 1-5 only.

Summary of enlarged-homestead designations—Continued.

State.	Outstanding July 1, 1911.	New designa- tions during fiscal year.	Cancellations during fiscal year.	Outstanding June 30, 1912.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>
Montana.....	31,853,530	175,566	320	32,028,776
Nevada.....	49,512,960	.....	.....	49,512,960
New Mexico.....	16,306,675	136,977	.....	16,443,652
Oregon.....	11,213,661	144,227	.....	11,357,888
Utah:				
Sections 1-5 only.....	6,765,780	177,891	.....	6,943,671
Section 6.....	1,374,947	16,380	a 189,727	1,201,600
	8,140,727	194,271	.....	8,145,271
Washington.....	3,402,896	.....	.....	3,402,896
Wyoming.....	17,538,941	52,671	3,639	17,587,973
	190,254,495	1,201,513	218,848	191,237,160

a Cancellation of designation under sec. 6, approved Feb. 16, 1912; 189,478 acres transferred to secs. 1-5 only.

There has been a large increase in the number of petitions for designation referred to the land-classification board. Previous to July 1, 1911, a total of 594 petitions had been filed; during the present fiscal year 511 petitions were received. Owing to the fact that but a small force could be assigned to make the necessary field investigations, only 299 petitions were disposed of during the fiscal year. The geographic distribution of the petitions and the action taken are indicated in the following table:

Action on enlarged-homestead petitions during the fiscal year ended June 30, 1912.

State.	Out- standing July 1, 1911.	Received during the year.	Designations made.			Acted on during the year	Pending.
			All.	Part.	Refused.		
Arizona.....	1	5	2	4	0	6	0
Colorado.....	5	10	1	1	1	3	12
Idaho.....	79	256	16	17	82	115	220
Montana.....	24	134	38	24	38	100	58
Nevada.....	0	0	0	0	0	0	0
New Mexico.....	11	32	16	10	12	38	5
Oregon.....	8	33	2	7	7	16	25
South Dakota.....	0	1	0	0	1	1	0
Utah.....	3	7	0	1	1	2	8
Washington.....	3	15	0	0	2	2	16
Wyoming.....	3	18	2	5	9	16	5
	179	511	77	69	153	299	349

WATER RESERVES.

The withdrawal from entry of lands on which are situated springs, streams, or other watering places, which are valuable because of their control of adjacent public range, was initiated during the year. Six public water reserves were created during the year in the States of Utah and Wyoming, involving 23,143 acres in Utah and 62,979 acres in Wyoming.

**TOPOGRAPHIC BRANCH.****ORGANIZATION.**

The organization of the topographic branch remained the same as at the close of the last fiscal year, except for the termination of the duties of one inspector, and is as follows:

Chief geographer, R. B. Marshall.

Atlantic division, Frank Sutton, geographer in charge.

Central division, W. H. Herron, geographer in charge.

Rocky Mountain division, Sledge Tatum, geographer in charge.

Pacific division, T. G. Gerdine, geographer in charge.

Inspectors of topography, J. H. Renshawe, geographer, and W. M. Beaman, topographer.

On account of the increase in work in the Pacific division, due to increase in State cooperation in water-power investigations and in other features, a reorganization of that division has been made, to take effect July 1, 1912, as follows:

Northwestern division (Washington, Oregon, Idaho), T. G. Gerdine, geographer in charge.

Pacific division (California, Arizona, Utah, Nevada, Hawaii), George R. Davis, geographer in charge.

**PERSONNEL.**

The technical corps of the topographic branch was increased during the year by the appointment of 1 assistant topographer, 21 junior topographers, and 2 draftsmen. It was reduced 14 by transfers, resignations, and deaths. With these changes the technical force now includes 1 chief geographer, 10 geographers, 10 topographic engineers, 42 topographers, 43 assistant topographers, 55 junior topographers, and 11 draftsmen—a total of 172. In addition, 60 technical field assistants were employed during a whole or a part of the field season. One geographer, two topographers, and one assistant topographer are on leave without pay.

**PUBLICATIONS.**

The work of the topographic branch for the fiscal year is represented by 114 maps and 17 book publications, namely, Bulletins 458, 464, 466, 468, 469, 472, 473, 476, 477, 481, 482, 486, 487, 488, 489, 493, and 496, titles and brief summaries of which are given on pages 25–31; and a preliminary edition of 300 copies of the instructions relating to triangulation, traverse, levels, and the adjustment of instruments was issued. At the close of the year manuscripts for Bulletins 514, 515, and 518 (Results of spirit leveling in New York, Pennsylvania, and Ohio, respectively) were at the Government Printing Office; in addition, the manuscripts for eight bulletins have been assembled

and transmitted for publication as Results of spirit leveling in Florida (Bulletin 516), Alabama (Bulletin 517), Tennessee (Bulletin 519), Illinois, Kentucky, and Indiana, Results of triangulation and primary traverse in Ohio, and Results of triangulation and traverse in the United States.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1912 were:

Topographic surveys.....	\$359, 200
Surveying national forests.....	75, 000
	<hr/>
	434, 200

The allotments of the appropriations, which were adhered to so far as practicable, were as follows:

*Allotments from funds appropriated for topographic work, fiscal year 1912.*

	Topo- graphic surveys.	Surveying national forests.
Administrative expenses of Survey.....	\$19, 136	\$3, 918
Clerical assistance and supervision.....	15, 580	3, 190
Map editing.....	3, 336	684
Purchase and repair of instruments, stationery, etc.....	12, 118	2, 482
Millionth-scale map.....	20, 000	.....
Atlantic division, field work, in Alabama, Delaware, Florida, Georgia, Louisiana, Maine, Maryland, Mississippi, New Hampshire, New York, North Carolina, Pennsylvania, South Carolina, Tennessee, Vermont, Virginia, and West Virginia.....	69, 945	.....
Central division, field work, in Arkansas, Oklahoma, Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.....	59, 945	.....
Rocky Mountain division, field work, in Colorado, Montana, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming.....	66, 300	19, 663
Pacific division, field work, in Arizona, California, Idaho, Montana, Oregon, Utah, and Washington, and Territory of Hawaii.....	82, 840	45, 063
Work by land-classification board.....	10, 000	.....
	<hr/>	<hr/>
	359, 200	75, 000

COOPERATION.

Cooperation with several States has been maintained, as described in previous reports. The States and the amounts allotted by them are as follows:

*Allotments for cooperative work.*

California .....	\$14, 000
California river surveys, not met by Federal allotment....	7, 000
Illinois .....	13, 750
Iowa .....	2, 350
Kentucky .....	10, 000
Maine .....	4, 700
Maryland .....	1, 825
Michigan .....	2, 000
Minnesota .....	10, 000
Missouri .....	6, 000

Nebraska-----	\$1, 500
New York-----	10, 000
Ohio-----	28, 400
Oklahoma-----	1, 000
Oregon-----	15, 000
Pennsylvania-----	5, 328
Virginia-----	4, 250
Washington-----	13, 750
West Virginia-----	12, 000
Hawaii-----	15, 000
	<hr/>
	177, 853

## GENERAL OFFICE WORK.

Progress maps were kept up to date and new ones compiled when necessary; field notes in connection with horizontal and vertical control work were copied and catalogued; the report of the committee appointed by the Secretary of the Interior to determine the areas of the various acquisitions by the United States was submitted and accepted; and 205 examination papers for the junior topographer and topographic aid civil-service examinations were rated.

## SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1912, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 28,136 square miles, making the total area surveyed to date in the United States 1,160,396 square miles,<sup>1</sup> or 38.34 per cent of the entire country. In addition, 5,274 square miles of resurvey were completed, making the total area of actual surveys during the year 33,410 square miles.

In connection with these surveys 7,378 linear miles of primary levels were run, making 237,808 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,923 permanent bench marks were established. In addition, 1,261 linear miles of river surveys were run.

Triangulation stations to the number of 73 were occupied and 53 were permanently marked. Primary traverse lines aggregating 3,621 miles were run, in connection with which 404 permanent marks were set. In the course of this work 22,937 square miles were covered by primary control.

The area covered by topographic surveys in Alaska during the fiscal year 1911-12, as reported in detail on pages 74-78, was 14,706

<sup>1</sup> Includes 1,223 square miles of water area in Maryland not previously reported during the progress of field work but now added, as the total area of the State has been surveyed.



square miles—246 for publication on the scale of 1:62,500 and 14,460 for publication on the scale of 1:250,000.

Topographic surveys were also carried on in Hawaii, the area mapped during the fiscal year being 281 square miles, for publication on the scale of 1:31,680, making the total area in Hawaii surveyed to date 879 square miles. In connection with the surveys in Hawaii, 77 miles of primary and precise levels were run and 20 permanent bench marks established, making the total number of miles of primary and precise levels run by this survey in Hawaii 439.

*Present condition of topographic surveys of the United States and new areas surveyed in 1911-12.*

	New area surveyed in 1911-12.	Total area surveyed to June 30, 1912.	Percentage of total area of State surveyed to June 30, 1912.
	<i>Square miles.</i>	<i>Square miles.</i>	
Alabama.....	74	18,713	36
Arizona.....	25	64,461	57
Arkansas.....	337	21,380	40
California.....	3,985	103,311	65
Colorado.....	1,351	44,095	42
Connecticut.....		4,965	100
Delaware.....	194	1,202	51
District of Columbia.....		70	100
Florida.....	259	2,080	4
Georgia.....		17,337	29
Idaho.....	5,071	24,080	29
Illinois.....	1,017	12,110	21
Indiana.....		3,041	8
Iowa.....	290	11,066	19
Kansas.....		64,159	78
Kentucky.....	445	17,587	43
Louisiana.....	28	8,311	17
Maine.....	349	8,620	26
Maryland.....		12,327	100
Massachusetts.....		8,266	100
Michigan.....	268	5,385	9
Minnesota.....	837	5,138	6
Mississippi.....	55	1,889	4
Missouri.....	436	35,479	51
Montana.....	1,448	55,171	38
Nebraska.....	120	26,094	34
Nevada.....		50,675	46
New Hampshire.....		3,380	36
New Jersey.....		8,224	100
New Mexico.....	1,951	35,530	29
New York.....	686	41,606	84
North Carolina.....		17,661	34
North Dakota.....		9,716	14
Ohio.....	4,165	32,988	80
Oklahoma.....	524	39,215	55
Oregon.....	1,142	19,812	20
Pennsylvania.....	269	23,876	53
Rhode Island.....		1,248	100
South Carolina.....		5,640	18
South Dakota.....		18,594	24
Tennessee.....	118	20,911	50
Texas.....	580	67,387	25
Utah.....		67,905	79
Vermont.....	77	3,753	39
Virginia.....		29,980	70
Washington.....	1,025	22,619	33
West Virginia.....		24,170	100
Wisconsin.....		11,789	21
Wyoming.....	1,010	27,381	28
Hawaii.....	28,136 281	1,160,396 879	..... .....

*a Includes 1,223 square miles of water area not reported during progress of field work.*



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## ATLANTIC DIVISION.

## FIELD WORK.

## SUMMARY.

During the season topographic mapping was carried on in Alabama, Delaware, Florida, Georgia, Louisiana, Maine, Maryland, Mississippi, New Hampshire, New York, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia. This work comprised the survey of five quadrangles and the resurvey or revision of six quadrangles. In addition, 12 quadrangles were partly surveyed and 10 quadrangles were partly resurveyed or revised. The total new area mapped was 2,109 square miles—2,081 for publication on the scale of 1:62,500 and 28 for publication on the scale of 1:24,000. The area resurveyed was 1,392 square miles—1,329 for publication on the scale of 1:62,500, 43 for publication on the scale of 1:24,000, 19 for publication on the scale of 1:12,000, and 1 for publication on the scale of 1:9,600. In connection with this work 1,269 miles of primary levels were run and 327 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of Alabama, New York, North Carolina, Pennsylvania, South Carolina, Virginia, and West Virginia. The total area covered by this primary control was about 3,424 square miles, of which 3,198 square miles were controlled by primary traverse, 1,056 miles being run and 102 permanent marks set. Twenty-three triangulation stations were occupied and 17 were marked. The result of this work was to make control available in eighteen 15-minute quadrangles.

*Topographic surveys in Atlantic division from July 1, 1911, to June 30, 1912.*

## DETAILS OF WORK BY STATES.

*Alabama.*—At the beginning of the fiscal year an agreement for the continuation of cooperative topographic surveys in Alabama was made between the State geologist and the United States Geological Survey, each to contribute \$10,000 toward the work. Owing to the fact that the State money has not yet been made available by the State legislature, all expenses of the work in Alabama during the fiscal year were paid from Federal funds, and the State will contribute its share toward the continuation of the work as soon as practicable. The survey of the Alabama portion of the Florence quadrangle, in Colbert and Lauderdale counties, was begun by W. H. S. Morey, T. F. Slaughter, R. A. Kiger, and Roscoe Reeves, the area mapped being 13 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area C. W. Arnold ran 62 miles of primary levels; and for the control of this and the Gravelly Springs, Rogersville, Tuscumbia, Russellville, Haleysville, Glen Allen, Guin, Fayette, Gordo, Samantha, and Tuscaloosa quadrangles, in Colbert, Lauderdale, Franklin, Lawrence, Winston, Marion, Fayette, Pickens, and Tuscaloosa counties, C. B. Kendall and F. W. Crisp ran 484 miles of primary traverse and set 45 permanent marks.

In addition to the cooperative work in Alabama, the Adger and Searles quadrangles, in Tuscaloosa and Jefferson counties, were controlled by F. W. Crisp and C. W. Arnold, 76 miles of primary levels being run, in connection with which 22 permanent bench marks were established, and 127 miles of primary traverse being run, in connection with which 10 permanent marks were set.

*Delaware.*—The survey of the Delaware portion of the Seaford quadrangle, in Sussex County, was completed by J. M. Whitman, R. L. Harrison, and J. H. Le Feaver, the area mapped being 194 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of this quadrangle Mr. Le Feaver ran 18 miles of primary levels and established 4 permanent bench marks.

*Florida.*—The survey of the Palatka quadrangle, in Putnam and St. John counties, was completed by W. H. Griffin and J. H. Le Feaver, the area mapped being 259 miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet.

*Georgia-Tennessee.*—The resurvey of the Cohutta quadrangle (northeast quarter of the old Dalton 30-minute quadrangle), comprising 235 square miles in Murray, Fannin, and Gilmer counties, Ga., and 10 square miles in Polk County, Tenn., was completed by E. I. Ireland, C. W. Arnold, and Roscoe Reeves, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this quadrangle Mr. Arnold ran 47 miles of primary levels *and established 15 permanent bench marks.*

*Louisiana.*—The survey of the Baxter Bayou and Delta Bridge 7½-minute quadrangles, in the Tensas Basin, was continued by W. N. Vance and Olinus Smith, the area mapped being 28 square miles in West Carroll and Tensas parishes, for publication on the scale of 1:24,000, with a contour interval of 5 feet.

*Maine.*—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted \$4,700 and the United States Geological Survey \$4,500. The survey of the Bryant Pond quadrangle, comprising 214 square miles in Oxford County, was completed, and that of the Bethel quadrangle, in the same county, was begun, the area mapped being 135 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by Hersey Munroe, R. A. Kiger, Olinus Smith, J. B. Metcalfe, and K. E. Schlachter. For the control of these quadrangles K. F. Maxcy ran 57 miles of primary levels and established 15 permanent bench marks.

*Maryland.*—For the continuation of cooperative topographic work in Maryland the State geologist and the United States Geological Survey each allotted \$1,825. The resurvey of the Maryland portions of the Nanjemoy (northeast quarter of the old Fredericksburg 30-minute quadrangle) and Indian Head (southeast quarter of the old Mount Vernon 30-minute quadrangle) 15-minute quadrangles, in Charles and Prince George counties, was completed by R. L. Harrison, the area resurveyed being 129 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In addition to this work, Mr. Harrison revised the culture on the Brandywine and Prince Frederick 15-minute quadrangles, comprising the north half of the old Patuxent 30-minute quadrangle, and the Wicomico 15-minute quadrangle, comprising the northwest quarter of the old Nomini 30-minute quadrangle, all in Charles and Prince Georges counties.

*Mississippi-Alabama-Tennessee.*—The survey of the Iuka quadrangle, in Tishomingo County, Miss., Colbert and Lauderdale counties, Ala., and Hardin County, Tenn., was completed by J. F. McBeth and R. A. Kiger, the area mapped being 117 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. Of the area mapped, 55 square miles lies in Mississippi, 61 square miles in Alabama, and 1 square mile in Tennessee.

*New Hampshire.*—To meet the needs of the administration of the Weeks Act a special resurvey was made of an area covering 63 square miles in the White Mountains, Grafton County—1 square mile for publication on the scale of 1:9,600, with a contour interval of 20 feet; 19 square miles for publication on the scale of 1:12,000, with a contour interval of 20 feet; and 43 square miles for publication on the scale of 1:24,000, with a contour interval of 20 feet. This work was done by

Hersey Munroe, E. I. Ireland, W. H. S. Morey, Olinus Smith, R. A. Kiger, J. B. Metcalfe, J. H. Le Feaver, Roscoe Reeves, and E. E. Witherspoon. For the control of portions of this area, Messrs. Kiger, Witherspoon, and K. E. Schlachter ran 54 miles of primary levels and established 11 permanent bench marks. All expenses incurred in connection with this work were paid from the appropriations made in the Weeks Act.

*New York.*—The State engineer and surveyor of New York allotted \$10,000 for continuation of cooperative topographic surveys in the State, and the Federal Survey allotted a like sum for the same purpose. The survey of the Lowville, Dannemora, and Lyon Mountain quadrangles, in Lewis, Clinton, and Franklin counties, was completed by C. E. Cooke, J. M. Whitman, R. C. McKinney, J. I. Gayetty, W. H. S. Morey, Olinus Smith, J. B. Metcalfe, and J. H. Le Feaver, the area mapped being 553 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Number Four and Bonaparte quadrangles, in Herkimer, Lewis, Jefferson, and St. Lawrence counties, was begun by Messrs. Whitman, McKinney, Morey, Le Feaver, Roscoe Reeves, and E. E. Witherspoon, the area mapped being 133 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Lyon Mountain, Dannemora, and Number Four quadrangles and of the Ellenburg quadrangle, in Clinton County, R. A. Kiger, J. M. Perkins, and K. E. Schlachter ran 165 miles of primary levels and established 52 permanent bench marks. For the control of the Bonaparte quadrangle and of the Edwards and Gouverneur quadrangles, in Lewis, Jefferson, and St. Lawrence counties, C. B. Kendall ran 104 miles of primary traverse and set 7 permanent bench marks, and for the control of the Chateaugay quadrangle, in Franklin County, Mr. Kendall ran 44 miles of primary traverse and set 4 permanent marks. For the control of the Corning quadrangle, in Steuben County, G. T. Hawkins occupied 7 and marked 3 triangulation stations.

*North Carolina-South Carolina.*—For the control of the Gastonia quadrangle, in Gaston and Lincoln counties, N. C., and of the Pleasant Ridge quadrangle, in Gaston and Lincoln counties, N. C., and York County, S. C., F. W. Crisp and C. W. Arnold ran 105 miles of primary levels, establishing 35 permanent bench marks, and 93 miles of primary traverse, setting 22 permanent marks. Of this control, 27 miles of primary levels and 23 miles of primary traverse were run in the South Carolina portion of the Pleasant Ridge quadrangle, in connection with which 9 permanent bench marks and 5 permanent traverse marks were set.

*Pennsylvania.*—The Topographic and Geological Survey Commission of Pennsylvania allotted \$5,328.19 for the continuation of the



cooperative topographic survey of the State and the United States Geological Survey allotted a like sum. The survey of the Stoneboro and Mercer quadrangles, in Mercer, Crawford, Butler, and Lawrence counties, was completed by Robert Muldrow and R. C. McKinney, the area mapped being 269 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Mercer quadrangle Howard Mellinger ran 47 miles of primary levels and established 13 permanent bench marks. For the control of the Northeast quadrangle, in Erie County, K. W. Trimble ran 55 miles of primary levels and established 15 bench marks and G. T. Hawkins ran 72 miles of primary traverse and set 6 permanent marks, and for the control of the Stahlstown and Wind Gap quadrangles, in Westmoreland, Monroe, and Northampton counties, Mr. Hawkins occupied and marked 7 triangulation stations.

*Tennessee.*—The survey of the Hollow Springs quadrangle, in Coffee, Bedford, Cannon, and Rutherford counties, was completed by T. F. Slaughter, the area mapped being 117 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Murfreesboro quadrangle, in Rutherford County, Oscar Jones ran 60 miles of primary traverse and set 2 permanent marks. (See also pp. 108 and 109.)

*Tennessee-North Carolina.*—Revision of culture was completed by J. I. Gayetty over a portion of the Murphy quadrangle, in Polk and Monroe counties, Tenn., and Cherokee County, N. C.

*Vermont.*—The survey of the Woodstock quadrangle, in Windsor and Rutland counties, was completed by W. H. S. Morey and H. L. Dodge, the area mapped being 77 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this quadrangle Mr. Dodge ran 51 miles of primary levels.

*Virginia.*—For the continuation of cooperative topographic surveys in Virginia in 1912 the State geologist allotted \$4,250, to be met with an equal amount by the Federal Geological Survey. As the State money was available for expenditure in June, field work was begun at that time, all expenses being borne by the State. For the control of the Pocahontas, Tazewell, Grundy, Bristol, Abington, Jonesville, Pound, Clintwood, and Estillville quadrangles, in Tazewell, Mercer, Russell, Lee, and Wise counties, L. F. Biggs and R. C. Seitz ran 233 miles of double primary levels and established 69 permanent bench marks.

In addition to the cooperative work in Virginia, the resurvey of the Fairfax quadrangle (the northwest quarter of the Mount Vernon 30-minute quadrangle), in Fairfax, Prince William, and Loudoun counties, was begun by Robert Muldrow and R. C. McKinney, the area resurveyed being 36 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this

quadrangle E. E. Witherspoon ran 83 miles of primary levels and established 20 permanent bench marks and G. T. Hawkins ran 72 miles of primary traverse and set 6 permanent marks.

*West Virginia.*—For the continuation of cooperative topographic surveys in West Virginia the State geologist allotted \$12,000 and the United States Geological Survey allotted \$10,000. The resurvey of areas previously mapped resulted in the completion of the work on the Logan, Marshes, Flat Top, and Beckley (formerly called Red Star) quadrangles, the West Virginia portion of the Louisa quadrangle, and portions of the Crawford and Packs Ferry quadrangles, in Logan, Boone, Wyoming, Raleigh, Mercer, Summers, Fayette, Upshur, and Lewis counties. The total area mapped was 919 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet, the work being done by E. I. Ireland, Fred McLaughlin, J. H. Le Feaver, C. W. Arnold, S. A. Judson, and Roscoe Reeves. For the control of these areas and of the Hinton and Meadow Creek quadrangles Mr. McLaughlin, L. F. Biggs, Mr. Arnold, and Mr. Witherspoon ran 216 miles of primary levels and established 56 permanent bench marks and C. B. Kendall occupied 9 triangulation stations and marked 7.

#### OFFICE WORK.

The drafting of the following sheets was completed: Searle, Ala.; Cohutta, Ga.; Bryant Pond and Buckfield, Maine; Brandywine and Wicomico, Md. (revision); Iuka, Miss.-Ala.-Tenn.; Dannemora, Lyon Mountain, and Lowville, N. Y.; Rochester, N. Y. (revision); Mercer and Stoneboro, Pa.; Hollow Springs, Tenn.; Woodstock, Vt.; Flat Top, Logan, Beckley, and Marshes, W. Va.

Progress in the drafting of additional sheets was made as follows: Palatka, Fla., 15 per cent; Delta Bridge, La., 80 per cent; Baxter Bayou, La., 25 per cent; Indian Head, Md.-Va. (resurvey), 43 per cent; Nanjemoy, Md.-Va. (resurvey), 43 per cent; Bethel, Maine, 20 per cent; Murphy, N. C.-Tenn. (revision), 23 per cent; Louisa, W. Va., 33 per cent.

In the computing section the following computations and adjustments were made:

Primary-level circuits were adjusted and geographic positions were computed for the Tuscumbia (Ala.) and Florence (Ala.-Tenn.) quadrangles. Primary-level circuits in the Iuka quadrangle (Ala.-Miss.-Tenn.) were adjusted. Geographic positions were computed for the Barton, Chickasaw, Cottondale, Fayette, Glen Allen, Gordo, Guin, Haleysville, Mantua, Powers, Russellville, Samantha, and Tuscaloosa (Ala.) and Gravelly Springs and Rogersville (Ala.-Tenn.) quadrangles.

Geographic positions were computed for the Arredondo, Ates Creek, Citra, Dinner Island, Eureka, Green Cove Springs, Hague,

Hawthorn, Interlachen, Lawtey, Palatka, Starke, and Welaka quadrangles (Fla.).

Primary-level circuits in the Cohutta and Spring Place quadrangles (Ga.-Tenn.) were adjusted.

Primary-level circuits in the Bethel, Bryant Pond, and Norway quadrangles (Maine) were adjusted.

Primary-level circuits in the Indian Head and Nanjemoy quadrangles (Md.-Va.) were adjusted.

Primary-level circuits were adjusted in the Dannemora, Lowville, Lyon Mountain, and Number Four quadrangles (N. Y.). Geodetic distances and positions were computed in the Corning, Elmira, and Hammondsport quadrangles (N. Y.).

Computations of positions of international boundary monuments between New York and Canada along the north borders of the Chateaugay, Ellenburg, Malone, Moira, Mooers, and Rouses Point quadrangles (N. Y.) were made.

Primary-level circuits in the Mercer quadrangle (Pa.) were adjusted. Geodetic distances and positions were computed in the Mauch Chunk, Somerset, Stahlstown, Wilpen, Windber, and Windgap quadrangles (Pa.). Geographic positions were computed and primary-level circuits were adjusted for the Northeast quadrangle (Pa.-N. Y.).

Primary-level circuits were adjusted and geographic positions were computed for the Fairfax and Haymarket (Va.) and Washington (Va.-Md.-D. C.) quadrangles.

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Beckley, Crawford, Flat Top, and Sandrun quadrangles (W. Va.). Primary-level circuits in the Logan and Marshes quadrangles (W. Va.) were adjusted. Geodetic distances and positions in the Meadow Creek and Packs Ferry quadrangles (W. Va.) were computed.

Level lists were revised and assembled, after all necessary computations had been made, and transmitted to the editor for publication as bulletins for Alabama (Bulletin 517), Florida (Bulletin 516), New York (Bulletin 514), Pennsylvania (Bulletin 515), and Tennessee (Bulletin 519).

#### CENTRAL DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Arkansas (extending over a small area in Oklahoma), Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Ohio. This work comprised the survey of 12 quadrangles and the resurvey of 1

quadrangle, in addition to which 40 quadrangles and 2 river projects were partly surveyed, 3 quadrangles were partly resurveyed, and 1 quadrangle was partly revised. The total new area mapped was 7,815 square miles—357 for publication on the scale of 1:125,000, 7,408 for publication on the scale of 1:62,500, and 50 for publication on the scale of 1:24,000. The area resurveyed was 554 square miles, for publication on the scale of 1:62,500. In connection with this work 3,664 miles of primary levels were run and 957 permanent bench marks established.

Primary traverse was carried on at different times by five parties, the work being distributed over portions of Illinois, Iowa, Michigan, Minnesota, Missouri, and Wisconsin. The total area covered by this primary control was about 10,207 square miles, 2,359 linear miles of primary traverse being run and 228 permanent marks set. The result of this work was to make control available in 102 quadrangles and 1 river project.

Topographic surveys in central division from July 1, 1911, to June 30, 1912.

State.	Con- tour inter- val.	For publication on scale of—				Total area sur- veyed.	Primary levels.		Primary traverse.	
		1:125,000; new.	1:62,500.		1:24,000; new.		Dis- tance.	Bench marks.	Dis- tance.	Perma- nent marks.
			New.	Resur- vey.						
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>	
Arkansas .....	50	337	.....	.....	.....	337	.....	.....	.....	.....
Oklahoma.....	50	20	.....	.....	.....	20	.....	.....	.....	.....
Illinois.....	10-20	.....	967	4	50	1,021	420	146	1,078	91
Indiana.....	.....	.....	.....	.....	.....	.....	<sup>a</sup> 66	29	.....	.....
Iowa.....	20	.....	290	.....	.....	290	115	31	115	10
Kentucky.....	20-50	.....	445	444	.....	889	252	54	.....	.....
Michigan.....	20	.....	268	.....	.....	268	<sup>b</sup> 371	94	304	40
Minnesota.....	10-20	.....	837	.....	.....	837	235	68	677	61
Missouri.....	20	.....	436	106	.....	542	150	17	75	6
Ohio.....	10-20	.....	4,165	.....	.....	4,165	2,055	518	.....	.....
Wisconsin.....	.....	.....	.....	.....	.....	.....	.....	.....	110	20
.....		357	7,408	554	50	8,369	3,664	957	2,359	228

<sup>a</sup> 66 miles precise levels. <sup>b</sup> 68 miles precise levels.

DETAILS OF WORK BY STATES.

*Arkansas-Oklahoma.*—The survey of the De Queen quadrangle, in Polk, Howard, and Sevier counties, Ark., and McCurtain County, Okla., was completed by H. H. Hodgeson, W. R. Schreiner, and L. H. Williams, the area mapped being 357 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. Of this area 20 square miles lies in Oklahoma.

*Illinois.*—The governor of Illinois allotted \$10,000 for the continuation of cooperative topographic surveys in Illinois, and the United States Geological Survey allotted a like sum. The governor

also made an additional allotment of \$3,750 for a survey of the overflowed lands within the State, which was met by an allotment of \$1,250 by the Federal Survey. The mapping of the Colchester quadrangle, in McDonough, Hancock, and Schuyler counties, was completed, the area mapped being 128 square miles, and that of the Illinois portion of the Renault quadrangle, in Randolph and Monroe counties, was also completed, the area mapped being 159 square miles. The survey of the Sumner quadrangle, comprising 233 square miles in Lawrence, Edwards, Richland, and Wabash counties; of the Lincoln quadrangle, comprising 228 square miles in Logan County; and of the Illinois portion of the Crystal City quadrangle, comprising 28 square miles in Monroe County, was completed. The survey of the Centralia quadrangle, in Marion, Clinton, Bond, and Washington counties, was begun, the area mapped being 191 square miles. The resurvey of the Ottawa quadrangle, in Lasalle County, was begun, the area mapped being 4 square miles. This work was all for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet, and was done by Frank Tweedy, C. W. Goodlove, L. L. Lee, F. W. Hughes, J. B. Leavitt, S. R. Truesdell, and W. S. Gehres. For the control of these areas and of the Macomb quadrangle, in McDonough and Schuyler counties, C. R. French and R. G. Clinite ran 240 miles of primary levels and established 83 permanent bench marks. For the control of the Centralia quadrangle and of the Vandalia, Ottawa, Streator, Alto Pass, Carbondale, Jonesboro, Du Quoin, Iuka, Richview, Mount Vernon, Ina, and Pinkneyville quadrangles, in Marion, Jefferson, Washington, Franklin, Perry, Clinton, Fayette, Lasalle, Jackson, and Union counties, J. R. Ellis and P. W. McMillen ran 278 miles of primary traverse and set 23 permanent marks. For the control of the Forreston, Oregon, Freeport, Lena, Mount Carroll, Amboy, Pecatonica, Dixon, Rochelle, Walnut, Woosung, Jacksonville, Pearl, Jerseyville, Rushville, Winchester, Macomb, Vermont, Roodhouse, Edwardsville, Carlinsville, Brighton, Harvel, Hettick, Litchfield, Staunton, Mulberry Grove, New Douglas, and Coffeen quadrangles, in Stephenson, Ogle, Carroll, Jo Daviess, Winnebago, Lee, Bureau, Whiteside, Morgan, Greene, Jersey, Schuyler, Scott, McDonough, Fulton, Macoupin, Montgomery, Christian, Bond, and Madison counties, J. H. Wilson ran 636 miles of primary traverse and set 54 permanent marks.

Under the allotment for overflowed lands L. L. Lee and J. B. Leavitt completed the survey of the Spoon River project, in Fulton County, the area mapped being 26 square miles. The survey of the Embarrass River project, in Jasper and Cumberland counties, was completed by Messrs. Lee and Leavitt and H. W. Peabody, the area mapped being 24 square miles. This work was for publication on the scale of 1:24,000, with a contour interval of 5 feet. For the con-

trol of the Spoon River project Mr. Leavitt ran 33 miles of primary levels and established 10 permanent bench marks. For the control of the Embarrass River project R. G. Clinite ran 27 miles of primary levels and established 18 permanent bench marks. For the control of the Saline River project, in Saline, Gallatin, Williamson, and Hardin counties, Mr. Clinite ran 120 miles of primary levels and established 35 permanent bench marks and J. R. Ellis ran 164 miles of primary traverse and set 14 permanent marks.

*Indiana.*—For the control of the Paoli, New Albany, New Salisbury, and Salem quadrangles, in Lawrence, Washington, Orange, Clark, Floyd, and Harrison counties, E. L. McNair ran 66 miles of precise levels and established 29 permanent bench marks.

*Iowa.*—The State geologist of Iowa allotted \$1,750 for the continuation of cooperative topographic surveys in Iowa, and the Federal Survey allotted an equal amount. In the spring of 1912 an additional sum of \$600 was made available by the State geologist for field work on the Boone and Story City quadrangles. The survey of the Madrid quadrangle, comprising 223 square miles in Boone and Dallas counties, and of the unmapped portion of the Slater quadrangle, covering 67 square miles in Polk and Story counties, was completed by W. L. Miller, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Madrid quadrangle Howard Clark ran 36 miles of primary levels and established 10 permanent bench marks.

For the control of the Boone and Story City quadrangles, in Story, Boone, Hamilton, and Webster counties, S. R. Archer ran 79 miles of primary levels and established 21 permanent bench marks, and for the control of these areas and of the Ogden and Nevada quadrangles, in Greene, Boone, Webster, Story, and Hamilton counties, J. R. Ellis ran 115 miles of primary traverse and set 110 permanent bench marks.

*Kentucky.*—The Kentucky Geological Survey allotted \$10,000 for the continuation of cooperative topographic surveys in that State, and the Federal Survey allotted a like sum. The survey of the Dunmor quadrangle, comprising 238 square miles in Ohio, Logan, Butler, and Muhlenberg counties, and of the unmapped portion of the Drakesboro quadrangle, covering 36 square miles in the same counties, was completed, and the survey of the Little Muddy quadrangle, in Butler, Warren, and Logan counties, was begun, the area mapped being 171 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. This work was done by C. W. Goodlove, W. A. Reiter, N. E. Ballmer, and C. W. Wardle. The resurvey of the Buckhorn (formerly called Crockettville) and Troublesome quadrangles, comprising the north half of the old Hazard 30-minute quadrangle, in Breathitt, Perry, Leslie, and Knott counties, was completed by J. R. Eakin, J. B. Leavitt, L. B.



Roberts, S. R. Archer, Edward Hyatt, jr., I. B. Gilbert, Stanley Hargen, and W. H. Phelps, the area resurveyed being 444 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Dunmor, Drakesboro, and Little Muddy quadrangles C. W. Wardle and E. C. Bibbee ran 178 miles of primary levels and established 40 permanent bench marks. For the control of the Troublesome quadrangle Mr. Archer ran 74 miles of primary levels and established 14 permanent bench marks.

*Michigan.*—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted \$2,000, which was met with a like sum by the United States Geological Survey. The mapping of the Michigan portions of the Pioneer, Alvordton, Wauseon, and Swanton quadrangles, covering 144 square miles in Lenawee, Amboy, Hillsdale, and Monroe counties, was completed, for publication on the scale of 1:62,500, with a contour interval of 10 feet, the work being done by J. H. Jennings, W. N. Vance, Fred Graff, jr., H. W. Peabody, N. E. Ballmer, and W. H. Rayner. The Ohio portions of these quadrangles were surveyed in cooperation with the State of Ohio, as reported on pages 119–120. For the control of these areas and of the Hudson quadrangle, in Hillsdale and Lenawee counties, Howard Clark, C. R. French, A. D. Duck, F. J. Mabrey, Philip Flitman, and C. W. Howell ran 63 miles of primary levels and established 20 permanent bench marks. For the control of the Grand Rapids, Hastings, Lowell, Muir, Ionia, Vermontville, Jenison, and Holland quadrangles, in Kent, Ionia, Clinton, Eaton, Barry, Ottawa, and Allegan counties, L. D. Townsend ran 186 miles of primary levels and established 45 permanent bench marks. For the control of the Springport, Marshall, Homer, Spring Arbor, Hillsdale, and Reading quadrangles, in Jackson, Calhoun, Eaton, Ingham, and Hillsdale counties, J. R. Ellis ran 50 miles of primary traverse and set 5 permanent marks.

In addition to the cooperative work in Michigan the survey of the Houghton quadrangle, in Houghton County, was continued by A. M. Walker, L. D. Townsend, and Howard Clark, the area mapped being 124 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Houghton quadrangle Mr. Clark ran 54 miles of primary levels and established 10 permanent bench marks, and for the control of this area and of the Beacon Hill, Winona, Greenland, Paynesville, Rubicon, and Sidnaw quadrangles, in Houghton, Ontonagon, and Baraga counties, E. L. McNair ran 68 miles of precise levels and established 19 permanent bench marks.

*Michigan-Wisconsin.*—For the control of the Watersmeet, Kenton, Star Lake, State Line, Beechwood, Iron River, Sagola, Norway, Iron Mountain, Commonwealth, Three Lakes, Monico, Elcho, Antigo,



Hermansville, Bark River, and Escanaba quadrangles, in Ontonagon, Houghton, Gogebic, Iron, Dickinson, Delta, and Menominee counties, Mich., and Forest, Florence, Oneida, Vilas, and Langlade counties, Wis., E. L. McNair ran 364 miles of primary traverse and set 55 permanent marks, of which 110 miles were run and 20 marks set in Wisconsin and 254 miles were run and 35 permanent marks set in Michigan.

*Minnesota.*—The State drainage engineer of Minnesota allotted \$10,000 for the continuation of cooperative topographic work in that State and the United States Geological Survey made an equal allotment. The survey of the unmapped portions of the Underwood quadrangle, covering 192 square miles in Ottertail County; of the Fergus Falls quadrangle, covering 169 square miles in Ottertail County; and of the Ashby quadrangle, covering 87 square miles in Douglas, Grant, and Ottertail counties, was completed. The survey of the Battle Lake quadrangle, in Ottertail County, was begun, the area mapped being 181 square miles; that of the Perham quadrangle, in Ottertail and Becker counties, was begun, the area mapped being 196 square miles; and that of the Dora quadrangle, in Ottertail and Becker counties, was begun, the area mapped being 12-square miles. These areas were mapped for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet, and the work was done by C. L. Sadler, F. B. Barrett, O. H. Nelson, L. B. Roberts, and W. A. Reiter. For the control of the Perham quadrangle J. M. Ray ran 78 miles of primary levels and established 23 permanent bench marks and J. R. Ellis ran 42 miles of primary traverse and set 5 permanent marks. For the control of the Dora and Pelican Rapids quadrangles, in Ottertail and Becker counties, Mr. Ray ran 157 miles of primary levels and established 45 permanent bench marks; and for the control of these areas and of the Barnesville, Hawley, Lake Park, Flom, Faith, Ogema, Many Points, Detroit Lake, Senjen, Lonnrot, and New York Mills quadrangles, in Becker, Ottertail, Clay, Norman, Williams, and Clearwater counties, Mr. Ellis and P. W. McMillan ran 348 miles of primary traverse and set 34 permanent marks. For the control of the Cross Lake, Emily, Aitkin, McGregor, Seavey, Wealthwood, Deerwood, Brainerd, Rucker, Onamia, and Opstead quadrangles, in Cross Lake, Aitkin, Crow Wing, Mille Lacs, and Kanabec counties, E. L. McNair and A. D. Duck ran 287 miles of primary traverse and set 22 permanent marks.

*Missouri.*—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted \$6,000 and the United States Geological Survey allotted an equal amount. The survey of the Green City quadrangle, comprising 228 square miles in Putnam, Adair, and Sullivan counties, and of the unmapped portion of the Queen City quadrangle, covering 208 square miles in Schuyler,

Adair, and Putnam counties, was completed by W. J. Lloyd, F. W. Hughes, W. S. S. Johnson, and W. S. Gehres, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Mecca quadrangle (the northeast quarter of the old Kansas City 30-minute quadrangle), in Clay, Clinton, and Platte counties, was begun by H. H. Hodgeson and J. B. Leavitt, the area mapped being 106 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Green City and Queen City quadrangles P. W. McMillan and James Rayburn ran 83 miles of primary levels and established 17 permanent bench marks. For the control of the Mecca quadrangle Mr. Leavitt and P. W. McMillan ran 67 miles of primary levels, and for the control of this area and of the Kansas City, Independence, and Gower quadrangles, in Platte, Clay, and Clinton counties, J. R. Ellis ran 75 miles of primary traverse and set 6 permanent marks.

*Ohio.*—The governor of Ohio allotted \$28,400 in addition to the unexpended balance of last year's fund, amounting to about \$3,000, for the continuation of the cooperative topographic survey of that State and the United States Geological Survey allotted \$15,000. The survey of the unmapped portions of the Jackson quadrangle, covering 87 square miles in Jackson, Vinton, and Ross counties; of the New Comerstown quadrangle, covering 154 square miles in Coshocton, Tuscarawas, and Holmes counties; of the Oelina quadrangle, covering 51 square miles in Mercer and Van Wert counties; of the Van Wert quadrangle, covering 174 square miles in Paulding and Van Wert counties; of the Circleville quadrangle, covering 80 square miles in Pickaway, Ross, and Fairfield counties; of the Navarre quadrangle, covering 178 square miles in Starke, Holmes, Wayne, and Tuscarawas counties; of the Era quadrangle, covering 210 square miles in Pickaway, Ross, and Madison counties; and of the Sidney quadrangle, covering 168 square miles in Shelby, Logan, Champaign, and Auglaize counties, was completed. The survey of the Paulding quadrangle, covering 225 square miles in Paulding County; of the Bryan quadrangle, covering 224 square miles in Williams and Defiance counties; and of the Roxabel quadrangle, covering 231 square miles in Ross County, was completed. The survey of the Ohio portions of the Berne quadrangle, covering 48 square miles in Mercer and Van Wert counties; of the Bobo quadrangle, covering 48 square miles in Van Wert and Paulding counties; of the Halls Corners quadrangle, covering 48 square miles in Paulding County; of the Butler quadrangle, covering 48 square miles in Williams and Defiance counties; of the Edon quadrangle, covering 39 square miles in Williams County; of the Pioneer quadrangle, covering 179 square miles in Williams County; of the Alvordton quadrangle, covering 184 square miles in Williams and Fulton counties; of the Wauseon quadrangle, covering

190 square miles in Fulton County; and of the Swanton quadrangle, covering 197 square miles in Fulton and Lucas counties, was completed. The Michigan portions of the last four quadrangles were mapped in cooperation with that State, as reported on page 117. The survey of the following quadrangles was begun: Millersburg, in Holmes and Wayne counties, the area mapped being 86 square miles; Fredericktown, in Knox, Licking, and Morrow counties, 159 square miles; Cardington, in Morrow, Marion, and Delaware counties, 202 square miles; Perrysville, in Richland, Knox, and Ashland counties, 122 square miles; Shauck, in Richland, Knox, and Morrow counties, 65 square miles; Coshocton, in Coshocton and Holmes counties, 119 square miles; Gambier, in Knox County, 197 square miles; Siam, in Seneca and Huron counties, 118 square miles; Loudonville, in Ashland and Holmes counties, 92 square miles; Troy, in Shelby, Logan, Champaign, and Miami counties, 203 square miles; and Brinkhaven, in Coshocton, Knox, and Holmes counties, 39 square miles. The total area mapped in Ohio was 4,165 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. The work was done by J. H. Jennings, G. S. Smith, W. H. Griffin, Merrill Hackett, W. L. Miller, W. N. Vance, A. P. Meade, Fred Graff, jr., S. G. Lunde, J. A. Duck, A. J. Ogle, F. W. Hughes, H. W. Peabody, J. L. Lewis, O. G. Taylor, J. H. Wilson, W. S. S. Johnson, L. D. Townsend, N. E. Ballmer, Howard Clark, W. H. Rayner, L. B. Glasgow, L. H. Williams, and C. W. Howell.

A small area in the West Columbus quadrangle, in Franklin, Pickaway, and Fairfield counties, was revised by Mr. Duck.

For the control of the Celina quadrangle C. W. Howell ran 5 miles of primary levels. For the control of the Bryan quadrangle Mr. Howell, A. D. Duck, C. R. French, and C. E. Mills ran 101 miles of primary levels and established 27 permanent bench marks. For the control of the Sidney quadrangle E. C. Bibbee ran 7 miles of primary levels and established 2 permanent bench marks. For the control of the Paulding quadrangle Mr. Mills ran 69 miles of primary levels and established 18 permanent bench marks. For the control of the Swanton quadrangle F. J. Mabrey ran 77 miles of primary levels and established 18 permanent bench marks. For the control of the Fredericktown, Cardington, Perrysville, and Shauck quadrangles Mr. Bibbee, Philip Flitman, Mr. Mabrey, Mr. Howell, and Howard Clark ran 286 miles of primary levels and established 78 permanent bench marks. For the control of the Era quadrangle J. J. McNulta ran 72 miles of primary levels and established 21 permanent bench marks. For the control of the Butler quadrangle Mr. Clark and Mr. Howell ran 18 miles of primary levels and established 6 permanent bench marks. For the control of the Wauseon quadrangle Mr. Clark ran 98 miles of primary levels and established 25

permanent bench marks. For the control of the Roxabel quadrangle Mr. McNulta ran 127 miles of primary levels and established 25 permanent bench marks. For the control of the Edon quadrangle Mr. French ran 23 miles of primary levels and established 6 permanent bench marks. For the control of the Halls Corners quadrangle Mr. Duck ran 24 miles of primary levels and established 6 permanent bench marks. For the control of the Troy quadrangle Mr. McNulta and Mr. Bibbee ran 86 miles of primary levels and established 32 permanent bench marks. For the control of the Pioneer quadrangle Mr. Howell, Mr. Duck, and Mr. French ran 96 miles of primary levels and established 29 permanent bench marks. For the control of the Alvordton quadrangle Mr. Howell, Mr. Clark, and Mr. Flitman ran 73 miles of primary levels and established 17 permanent bench marks.

For the control of the Mount Gilead, Shiloh, Bellefontaine, Georgetown, St. Paris, Bucyrus, Brinkhaven, Siam, Norwalk, Gambier, Loudonville, Sandusky, and Waynesville quadrangles, in Morrow, Marion, Crawford, Richland, Huron, Champaign, Clark, Logan, Brown, Seneca, Coshocton, Holmes, Knox, Erie, Green, Montgomery, Sandusky, Wayne, and Ashland counties, Messrs. Flitman, Mills, Bibbee, McNulta, Archer, Clark, and Howell ran 893 miles of primary levels and established 208 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: De Queen, Ark.-Okla.; Colchester, Lincoln, Sumner, Embarrass River drainage, and Spoon River drainage, Ill.; Galena, Ill.-Iowa; Madrid and Slater, Iowa; Troublesome, Dunmor, Buckhorn, Drakesboro, and Monticello, Ky.; Ashby and Fergus Falls, Minn.; Queen City, Mo.; Alvordton, Pioneer, Swanton, and Wauseon, Ohio-Mich.; Celina, Circleville, Era, Jackson, Bryan, Navarre, New Comerstown, Paulding, Sciotoville, Sidney, and Van Wert, Ohio.

Progress in the drafting of additional sheets was made as follows: Crystal City, Ill., 10 per cent; Renault, Ill., 80 per cent; Little Muddy, Ky., 52 per cent; Grand Rapids, Mich., 12 per cent; Houghton, Mich., 77 per cent; Battle Lake, Minn., 55 per cent; Underwood, Minn., 23 per cent; Berne, Ohio, 22 per cent; Bobo, Ohio, 22 per cent; Butler, Ohio, 22 per cent; Edon, Ohio, 18 per cent; Halls Corners, Ohio, 22 per cent; Roxabel, Ohio, 45 per cent; Troy, Ohio, 25 per cent.

In the computing section the following computations and adjustments were made:

Primary-level circuits were adjusted and geographic positions were computed for the Carbondale, Centralia, Equality, Marion, Odell, Ottawa, Stonefort, and Streator (Ill.), and Shawneetown (Ill.-Ky.)

quadrangles. Primary-level circuits were adjusted in the Avon, Canton, Galesburg, Hardinville, Moonshine, Newton, and Rosehill (Ill.), Birds and Vincennes (Ind.-Ill.), and Crystal City and Renault (Ill.-Mo.) quadrangles. Geographic positions were computed for the Amboy, Brighton, Carlinville, Coffeen, Dixon, DuQuoin, Edwardsville, Forreston, Freeport, Harvel, Hettick, Hoyleton, Iuka, Jacksonville, Lena, Litchfield, Macomb, Marseilles, Morrisonville, Mount Carroll, Mount Vernon, Mulberry Grove, Oregon, Pearl, Pecatonica, Pinckneyville, Richview, Rochelle, Roodhouse, Rushville, Sandwich, Staunton, Vandalia, Vermont, Walnut, and Winchester (Ill.) and Alto Pass, Hardin, and Jonesboro (Ill.-Mo.) quadrangles.

A precise-level circuit in the Paoli and Salem (Ind.) and New Albany (Ind.-Ky.) quadrangles was adjusted.

Primary-level circuits were adjusted in the Madrid, Slater, and Story City quadrangles (Iowa). Geographic positions were computed for the Boone, Nevada, Ogden, and Story City quadrangles (Iowa).

Primary-level circuits were adjusted in the Buckhorn, Creelsboro, Daysville, Drakesboro, Dunmor, Glenmore, Jabez, Lee City, Little Muddy, Monticello, Nortonville, Russellville, Salmons, and Troublesome quadrangles (Ky.).

Precise and primary level circuits were adjusted and geographic positions were computed for the Houghton quadrangle (Mich.). Precise level circuits were adjusted and geographic positions were computed for the Greenland, Paynesville, Rubicon, Sidnaw, and Winona quadrangles (Mich.). Primary-level circuits were adjusted and geographic positions were computed for the Adrian, Grand Rapids, Hudson, Ionia, Jenison, Lowell, and Muir quadrangles (Mich.). Primary-level circuits in the Holland (Mich.) and Edon (Ind.-Ohio-Mich.) quadrangles were adjusted. Geographic positions were computed for the Allegan, Bark River, Beacon Hill, Blissfield, Cedar Springs, Crystal Falls, Dundee, Escanaba, Hardwood, Hastings, Hermansville, Hillsdale, Homer, Kalamazoo, Kenton, Marshall, Norway, Sagola, Schoolcraft, Spring Arbor, Springport, Watersmeet, and Wayland (Mich.), Beechwood, Commonwealth, Iron River, Menominee special, and State Line (Mich.-Wis.), and Centerville and Reading (Mich.-Ind.) quadrangles.

Primary-level circuits were adjusted and geographic positions were computed for the Detroit Lake, Dora, Pelican Rapids, and Perham quadrangles (Minn.). Primary-level circuits in the Battle Lake and Underwood quadrangles (Minn.) were adjusted. Geographic positions were computed for the Aitkin, Barnesville, Brainerd, Deerwood, Emily, Flom, Hawley, Lake Park, Lonnrot, Many Points, New York Mills, Ogema, Senjen, Twin Valley, Ulen, and Wealthwood quadrangles (Minn.).



Primary-level circuits were adjusted in the Edna, Green City, and Queen City (Mo.) and Rulo (Mo.-Nebr.) quadrangles. Geographic positions were computed for the Independence, Mecca, and Plattsburg (Mo.) and Kansas City (Mo.-Kans.) quadrangles.

Primary-level circuits were adjusted and geographic positions were computed for the Bellefontaine, Brinkhaven, Bryan, Bucyrus, Cardington, Celina, Fredericktown, Gambier, Mount Gilead, Norwalk, Paulding, Perrysville, Plimpton, St. Paris, Shauck, Shiloh, Siam, and Van Wert (Ohio), Berne, Bobo, Butler, and Halls Corner (Ind.-Ohio), and Swanton (Ohio-Mich.) quadrangles. Primary-level circuits were adjusted in the Bainbridge, Chillicothe, Circleville, Era, Greenfield, Mount Sterling, Napoleon, Roxabel, Sandusky, Sardinia, Sidney, Troy, West Columbus, and Westerville (Ohio), Alvordton, Pioneer, and Wauseon (Ohio-Mich.), and Georgetown (Ohio-Ky.) quadrangles. Primary-traverse positions were computed for the Alger, Ashland, Continental, Defiance, Delaware, Delphos, East Liberty, Kenton, Larue, Mechanicsburg, Milford Center, New London, Richwood, South Charleston, Sycamore, and West Salem quadrangles (Ohio).

Geographic positions were computed for the Antigo, Brodhead, Browntown, Elcho, Monico, Monroe, Robbins, and Three Lakes (Wis.) and Star Lake (Wis.-Mich.) quadrangles.

Level lists were revised and assembled, after all necessary computations had been made, and transmitted to the editor for publication as bulletins for Illinois, Indiana, Kentucky, and Ohio. Primary traverse and triangulation lists for Ohio for 1898 to 1911, inclusive, were revised and assembled, after all necessary computations had been made, and transmitted for publication as a bulletin.

#### ROCKY MOUNTAIN DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Colorado, Montana, Nebraska, New Mexico, Oklahoma, Texas, and Wyoming. This work comprised the survey of 4 quadrangles and the resurvey of 1 quadrangle and 1 special area, in addition to which 20 quadrangles and 2 national parks were partly surveyed, 6 quadrangles were partly resurveyed, and 1 quadrangle was partly revised. The total new area mapped was 6,366 square miles—4,498 for publication on the scale of 1:125,000 and 1,868 for publication on the scale of 1:62,500. The area resurveyed was 2,312 square miles—1,899 for publication on the scale of 1:125,000, 218 for publication on the scale of 1:62,500, 180 for publication on the scale of 1:31,680, and 15 for publication on the scale of 1:9,600. In connection with this work,

1,251 miles of primary levels were run and 330 permanent bench marks were established. River-profile surveys were also made on two streams, the total distance traversed being 292 miles.

Primary triangulation was carried on at different times by one party, the work being distributed over portions of Colorado and New Mexico. The total area covered by this primary control was about 3,500 square miles, 27 triangulation stations being occupied and 21 marked. The result of this work was to make control available in 5 quadrangles and 1 special area.

Topographic surveys in Rocky Mountain division from July 1, 1911, to June 30, 1912.

State.	Con- tour inter- val.	For publication on scale of—						Total area sur- veyed.	Primary levels.	
		1:125,000.		1:62,500.		1:31,680.	1:9,600.		Dis- tance run.	Bench marks.
		New.	Resur- vey.	New.	Resur- vey.	Resur- vey.	Resur- vey.			
		Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Miles.	
Colorado.....	25, 50, 100	770	880	581	.....	.....	15	2,246	199	62
Montana.....	20, 100	653	.....	197	.....	180	.....	1,030	64	18
Nebraska.....	20	.....	.....	120	.....	.....	.....	120	117	35
New Mexico.....	50, 100	1,825	.....	126	.....	.....	.....	1,951	96	21
Oklahoma.....	50	504	1,019	.....	.....	.....	.....	1,523	573	141
Texas.....	25	.....	.....	580	.....	.....	.....	580	73	18
Wyoming.....	20, 25, 50	746	.....	264	218	.....	.....	1,228	129	35
		4,498	1,899	1,868	218	180	15	8,678	1,251	330

DETAILS OF WORK BY STATES.

*Colorado.*—The survey of the Mesa Verde National Park, in La Plata and Montezuma counties, was completed by R. W. Berry and C. A. Ecklund, the area mapped being 115 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The survey of the Red Mesa quadrangle, comprising 238 square miles in La Plata County, was completed by Messrs. Berry and Ecklund, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The survey of the unmapped portion of the Hahns Peak quadrangle, lying partly in the Park Range National Forest, Routt and Jackson counties, was completed by Gilbert Young and C. W. Rowell, the area mapped being 385 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, and the survey of the Meeker quadrangle, comprising 228 square miles in Rio Blanco and Moffat counties, was completed by the same party for publication on the scale of 1:62,500, with a contour interval of 50 feet. The survey of the Chromo quadrangle (formerly called Price), lying partly in the San Juan and Rio Grande national forests, Archuleta County, was continued by S. T. Penick, the area mapped being 385



square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The resurvey of the Leadville mining district (formerly mapped as the Leadville special area), comprising 15 square miles in Lake and Eagle counties, was completed by E. P. Davis and S. E. Taylor, for publication on the scale of 1:9,600, with a contour interval of 25 feet. The resurvey of the Castle Rock quadrangle, in El Paso, Elbert, and Douglas counties, was completed by C. G. Anderson and G. W. Lucas, the area mapped being 755 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, and the resurvey of a portion of the Ignacio quadrangle, lying partly in the San Juan National Forest, La Plata County, was completed by Mr. Anderson, the area resurveyed being 125 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Mesa Verde National Park and of the Hahns Peak, Red Mesa, and Meeker quadrangles Mr. Rowell and R. M. Copeland ran 184 miles of primary levels and established 52 permanent bench marks. For the control of the Leadville mining district Mr. Taylor ran 15 miles of primary levels and established 10 permanent bench marks and R. B. Robertson occupied 9 triangulation stations and marked 8.

A profile survey of a section of Grand River, in Colorado and Utah, was made by R. C. Seitz, the distance traversed being 192 miles, of which 131 miles was in Mesa, Garfield, Grand, Eagle, and Routt counties, Colo., and 61 miles in Emory County, Utah.

*Montana.*—The survey of the unmapped portions of the Brockton quadrangle, covering 103 square miles in Dawson County, and of the Homestead quadrangle, covering 94 square miles in Valley County, was completed by J. H. Wilke and C. P. McKinley, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the unmapped portion of the Marias Pass quadrangle (formerly called Midvale), lying partly in the Glacier National Park and in the Blackfeet, Flathead, and Lewis and Clark national forests, Teton and Flathead counties, was completed by R. T. Evans and F. L. Whaley, the area mapped being 433 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet; and the survey of the unmapped portion of the Nyack quadrangle, lying partly in the Glacier National Park and in the Blackfeet and Flathead national forests, Flathead County, was continued by Mr. Evans, W. J. Forster, Lee Morrison, and C. C. Holder, the area mapped being 220 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The resurvey of several townships comprising portions of the Divide and Willis quadrangles (previously reported as the Melrose special), in Silver Bow, Beaverhead, and Madison counties, was continued by R. H. Reineck, the area mapped being 180 square miles, for pub-

lication on the scale of 1:31,680, with a contour interval of 50 feet. For the control of the Brockton and Homestead quadrangles Mr. McKinley ran 64 miles of primary levels and established 18 permanent bench marks.

The profile survey of Clark Fork, in Montana and Idaho, was continued by R. C. Seitz, the distance traversed being 100 miles, of which 87 miles was in Sanders County, Mont., and 13 miles in Bonner County, Idaho.

*Nebraska.*—The State geologist of Nebraska allotted \$1,500 for cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum. The survey of the Nebraska portion of the Nemaha quadrangle, covering 94 square miles in Richardson and Nemaha counties, was completed by R. H. Reineck and C. C. Gardner, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Falls City quadrangle, in Richardson County, was begun by Mr. Gardner and R. R. Monbeck, the area mapped being 26 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Howe and Rulo quadrangles, in Nemaha, Holt, and Richardson counties, Mr. McKinley and C. P. Gross ran 117 miles of primary levels and established 35 permanent bench marks.

*New Mexico.*—The survey of the Alum Mountain quadrangle (formerly called Camp Vincent), in the Datil and Gila national forests, Grant and Socorro counties, was completed by A. B. Searle and F. H. Nelson, the area mapped being 476 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Raton quadrangle, in Colfax County, was continued by E. P. Davis and S. E. Taylor, the area mapped being 126 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. A survey was made by C. J. Ballinger of a portion of the Tularosa Desert, covering an area of 1,349 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. This work covered portions of the Tularosa, Gypsum Hills, Alamogordo, Tonuco, and Soudders quadrangles, in Otero County. For the control of the Raton quadrangle, Mr. Taylor and C. P. Gross ran 96 miles of primary levels and established 21 permanent bench marks and R. B. Robertson occupied 10 and marked 12 triangulation stations. For the control of the Alum Mountain quadrangle Mr. Robertson occupied 8 triangulation stations and marked 1.

*Oklahoma.*—The Director of the Oklahoma Geological Survey allotted \$1,000 for cooperative topographic surveys in that State and the Federal Geological Survey allotted a like sum. The survey of the Hominy quadrangle, in Payne and Tulsa counties, was begun in cooperation, but after the expenditure of all cooperative funds field

work was continued under an additional Federal allotment. The area mapped was 566 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet; of this area 62 square miles comprised a resurvey of a portion of the old Indian Territory survey. This work was done by Basil Duke, S. T. Penick, S. E. Taylor, C. P. McKinley, and C. W. Rowell. For the control of the Hominy quadrangle H. L. Caldwell ran 338 miles of primary levels and established 69 permanent bench marks.

In addition to the cooperative work in Oklahoma the resurvey of the Vinita quadrangle, comprising 957 square miles in Craig, Nowata, Mayes, Ottawa, Delaware, and Rogers counties, was completed by S. E. Taylor, C. P. McKinley, G. W. Lucas, and C. C. Holder, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of the Washunga quadrangle, in Grant and Kay counties, R. M. Copeland ran 235 miles of primary levels and established 72 permanent bench marks. (See also p. 114.)

*Texas.*—The survey of the Daingerfield quadrangle, comprising 250 square miles in Morris and Cass counties, was completed by C. P. McKinley and C. C. Holder, for publication on the scale of 1:62,500, with a contour interval of 25 feet, and that of the unmapped portions of the Gay Hill and Navasota quadrangles, covering 330 square miles in Burleson, Brazos, Washington, and Grimes counties, was completed by S. E. Taylor and C. A. Ecklund, for publication on the same scale and with the same contour interval. For the control of the Gay Hill and Navasota quadrangles Mr. Taylor and Mr. Ecklund ran 73 miles of primary levels and established 18 permanent bench marks.

*Wyoming.*—The survey of the Meeteetse quadrangle, comprising 215 square miles in Park County, and of the unmapped portion of the Oregon Basin quadrangle (formerly called Wiley), covering 49 square miles in Park County, was completed by C. C. Gardner, L. V. Fees, and C. C. Holder, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Cheyenne quadrangle, in Laramie County, was completed by Basil Duke and H. L. Caldwell, the area mapped being 746 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. The resurvey of the Hanna quadrangle (northeast quarter of the old Fort Steele 30-minute quadrangle), in Carbon County, was begun by F. E. Matthes, A. O. Burkland, J. H. Wilke, and C. J. Ballinger, the area mapped being 218 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Meeteetse quadrangle Mr. Gardner ran 6 miles of primary levels and established 2 permanent bench marks, for the control of the Cheyenne quadrangle Mr. Caldwell ran 72 miles of primary levels and established 23 permanent bench marks, and for the control of

the Hanna quadrangle Mr. Ballinger ran 51 miles of primary levels and established 10 permanent marks.

In addition to this work, the Wyoming portion of the Patrick quadrangle, in Goshen County, was partly revised by Lee Morrison.

#### OFFICE WORK.

The drafting of the following sheets was completed: Hahns Peak, Mesa Verde National Park, Red Mesa, Castle Rock, Leadville mining district, Ignacio (portion resurveyed), Colo.; Brockton, Homestead, Marias Pass, Clark Fork, Mont.; Alum Mountain, Silver City (small area revised), and Alamo National Forest, N. Mex.; Cheyenne, Oregon Basin, Meeteetse, and Green River, Wyo.; Daingerfield and Navasota, Tex.; Antlers, Claremore, and Nowata, Okla. (revision).

Progress in the drafting of additional sheets was made as follows: Chromo, Colo., 52 per cent; Meeker, Colo., 78 per cent; Grand River, Colo., 70 per cent; Divide, Mont., 19 per cent; Willis, Mont., 7 per cent; Marston, Mont., 15 per cent; Nyack, Mont., 63 per cent; Nemaha, Nebr., 41 per cent; Raton, N. Mex., 60 per cent; Tularosa, N. Mex., 63 per cent; Alamagordo, N. Mex., 3 per cent; Gypsum Hills, N. Mex., 66 per cent; Soudders, N. Mex., 2 per cent; Tonuco, N. Mex., 1 per cent; Hanna, Wyo., 84 per cent.

In the computing section the following computations and adjustments were made:

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Leadville quadrangle (Colo.). Primary-level circuits were adjusted in the Apishapa, Cortez, Elmore, Hahns Peak, La Plata, Lewis Creek, Mancos, Meeker, North Park, Red Mesa, and Spanish Peaks quadrangles (Colo.).

Primary-level circuits in the Brockton and Sand Butte quadrangles (Mont.) were adjusted.

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Raton quadrangle (N. Mex.). Geodetic distances and positions were computed for the Alum Mountain, Black Range, Laura Spring, Mogollon, Silver City, Steeple Rock, and Tonuco quadrangles (N. Mex.).

Primary-level circuits in the Navasota quadrangle (Tex.) were adjusted.

Primary-level circuits in the Cheyenne quadrangle (Wyo.) were adjusted.

#### PACIFIC DIVISION.

#### FIELD WORK.

#### SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Idaho (including portions of quadrangles in Mon-

tana), Oregon, Utah, and Washington. This work comprised the survey of 4 quadrangles, the partial survey of 48 quadrangles and 1 national park, the partial resurvey of 2 quadrangles, the revision of 1 quadrangle and 1 special area, and the partial revision of 1 quadrangle. The total new area mapped was 11,846 square miles—6,913 for publication on the scale of 1:250,000, 2,648 for publication on the scale of 1:125,000, 1,364 for publication on the scale of 1:62,500, and 921 for publication on the scale of 1:31,680. The area resurveyed was 1,016 square miles—851 for publication on the scale of 1:125,000 and 165 for publication on the scale of 1:62,500.

In connection with this work 1,194 miles of primary levels were run and 309 permanent bench marks were established. In addition, profile surveys were made of 12 rivers, the distance traversed being 969 miles, in connection with which 100 square miles were surveyed for publication on the scale of 1:31,680.

Topographic surveys were made in the Territory of Hawaii, covering portions of one island, embracing parts of eight 15-minute quadrangles and one special area, the area mapped being 281 square miles, for publication on the scale of 1:31,680, in connection with which 77 miles of primary levels were run and 20 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by three parties, the work being distributed over portions of California, Oregon, and Washington. The total area covered by this primary control was about 5,806 square miles, of which 529 were controlled by primary traverse, 206 miles being run and 74 permanent marks set. Twenty-three triangulation stations were occupied and 15 were marked. The results of this work made control available in 5 quadrangles and 1 national park.

*Topographic surveys in Pacific division from July 1, 1911, to June 30, 1912.*

## DETAILS OF WORK BY STATES.

*Arizona.*—The survey of the Phoenix quadrangle, in Maricopa County, was completed by T. P. Pendleton, the area mapped being 25 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. Culture was also brought up to date on the part of this quadrangle previously mapped.

*California.*—The Department of Engineering of California allotted \$14,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted a like sum. In the San Joaquin Valley the survey of the Holt, Woodward Island, Byron Hot Springs, and Bethany 7½-minute quadrangles and of the unmapped portions of the Stockton and Brentwood 7½-minute quadrangles, in San Joaquin, Contra Costa, and Alameda counties, was completed by Duncan Hannegan and J. L. Lewis, the area mapped being 296 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. The survey of the Union Island 7½-minute quadrangle, in San Joaquin County, was begun by Mr. Hannegan, J. P. Harrison, and Mr. Lewis, the area mapped being 27 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet.

In the Salinas Valley the survey of the Metz, King City, San Ardo (the southwest quarter of the Priest Valley 30-minute quadrangle, which is being mapped on a scale of 1:125,000), and Bradley 15-minute quadrangles was begun and that of the Soledad 15-minute quadrangle was continued, the area mapped being 229 square miles in Monterey and San Luis Obispo counties, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet. This work was done by Duncan Hannegan, Charles Hartmann, jr., E. R. Bartlett, and R. M. LaFollette.

In addition to the regular cooperative surveys in California the State Board of Control (Water Powers) made an allotment of \$7,000 for cooperative river surveys, the United States Geological Survey making no allotment but detailing its men to carry on the work. Under this plan profile surveys were made of the North, Middle, and South forks of American River, the Middle Fork of Feather River, Pit River, and Tuolumne River, the total distance traversed being 367 miles, in Sacramento, Placer, Eldorado, Butte, Plumas, Shasta, Lassen, Tuolumne, and Stanislaus counties. This work was done by J. G. Staack, J. P. Harrison, Charles Hartmann, jr., and T. J. Pendleton.

In addition to the cooperative work in California, the survey of the land area of the Monterey quadrangle, covering 148 square miles in Monterey County, was completed by C. F. Eberly and Cornelius Schnurr, for publication on the scale of 1:62,500, with a contour in-



terval of 25 feet. For the control of the Monterey quadrangle Mr. Schnurr ran 56 miles of primary levels and established 13 permanent bench marks. The survey of the Capitola quadrangle, in Monterey and Santa Cruz counties, was begun by E. R. Bartlett, the area mapped being 27 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet.

The survey of the unmapped portion of the Big Bar quadrangle, covering 16 square miles in the Trinity National Forest, was completed, and that of the Sawyers Bar quadrangle, in the same national forest, Trinity, Humboldt, and Siskiyou counties, was begun, the area mapped being 359 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. This work was done by J. P. Harrison. The resurvey of the Weaverville quadrangle (the northwest quarter of the old Red Bluff 1-degree quadrangle), lying partly in the Trinity National Forest, Trinity and Shasta counties, was completed by Oscar Jones, Bayard Knock, and K. W. Trimble, the area resurveyed being 851 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

The survey of the unmapped portion of the Bishop quadrangle, covering 205 square miles in Inyo and Mono counties, was completed, and that of the Long Valley quadrangle, lying partly in the Inyo and Mono national forests, Mono County, was begun by B. A. Jenkins, the area mapped being 435 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

The survey of the Borax Flat quadrangle, lying partly in the Sequoia National Forest, San Bernardino and Kern counties, was begun by J. P. Harrison and L. R. Ebert, the area mapped being 1,543 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. For the control of this quadrangle C. F. Urquhart and Charles Hartmann, jr., occupied 16 and marked 14 triangulation stations.

The survey of the unmapped portion of the Caliente quadrangle, covering 301 square miles in Kern County, was completed by J. W. Muller and K. W. Trimble, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

The survey of the Petaluma quadrangle, in Sonoma and Marin counties, was continued by Bayard Knock, the area mapped being 39 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet.

The survey of the unmapped portion of the Priest Valley quadrangle, lying partly in the Monterey National Forest, Monterey, San Benito, and Fresno counties (a portion of which was covered by the survey of the Coalinga oil district), was begun by B. A. Jenkins, D. H. Watson, and R. M. LaFollette, the area mapped being 360



square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

*Idaho.*—The survey of the Slug Creek quadrangle was completed and that of the Wayan, Freedom, Henry, and Preuss Range quadrangles, in Bear Lake and Bannock counties, was continued by Albert Pike, the area mapped being 309 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Field work on 205 square miles of this area was done on a scale of 1:31,680. (Work on this same area was reported last year as done in the Wayan 30-minute quadrangle.) For the control of the Wayan quadrangle D. S. Birkett ran 37 miles of primary levels and established 11 permanent bench marks. For the control of the Chatcolet and Fernwood quadrangles, in Kootenai and Shoshone counties, Mr. Birkett ran 93 miles of primary levels and established 30 permanent bench marks.

A profile survey of Salmon River, in Idaho and Adams counties, was made by O. G. Taylor, the distance traversed being 108 miles.

*Idaho-Montana.*—The survey of the Idaho portions of the Taft and St. Regis quadrangles, in Shoshone County, was continued by J. E. Blackburn and C. L. McWhorter, the area mapped being 365 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Idaho portions of this area D. S. Birkett ran 29 miles of primary levels and established 8 permanent bench marks, and for the control of the Montana portion of this area Mr. Birkett ran 6 miles of primary levels and established two permanent bench marks.

The survey of the Priest Lake 1-degree quadrangle (formerly called Panhandle), lying partly in the Pend Oreille and Kaniksu national forests, Bonner, Kootenai, Lincoln, and Shoshone counties, Idaho, and Flathead and Sanders counties, Mont., was completed by T. P. Pendleton and J. W. Muller, the area mapped being 1,320 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. Of the area mapped 163 square miles lie in Montana. In connection with this work the Sand Point 30-minute quadrangle, forming the southeast quarter of the Priest Lake quadrangle, was completely revised.

The survey of the Lolo quadrangle, in the Clearwater National Forest, was completed, and that of the Washington Creek, Weippe, and Quartz quadrangles, in the same forest, was begun, the total area mapped being 3,675 square miles, for publication on the scale of 1:250,000, with a contour interval of 200 feet. Of this area 3,240 square miles lie in Clearwater, Idaho, and Nez Perce counties, Idaho, and 435 square miles in Missoula County, Mont. This work was done by T. M. Bannon, J. G. Staack, and S. G. Lunde. For the control of this area L. F. Biggs ran 265 miles of primary levels and

established 68 permanent bench marks, all of the control being in Idaho.

*Oregon.*—The State engineer of Oregon allotted \$15,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum. The survey of the Willamette Valley was continued and resulted in the partial mapping of the Brownsville, Lebanon, Monroe, Albany, and Corvallis 15-minute quadrangles, in Linn, Benton, and Marion counties, the total area mapped being 269 square miles, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet. This work was done by E. R. Bartlett, A. J. Ogle, J. M. Rawls, and A. F. McNair. For the control of these areas Mr. Bartlett, E. M. Bandli, and A. G. Humphrey ran 189 miles of primary levels and established 45 permanent bench marks and C. F. Urquhart ran 149 miles of primary traverse and set 60 permanent marks.

The survey of the Oregon City and Boring quadrangles and the Oregon portion of the Troutdale quadrangle, in Clackamas and Multnomah counties, was continued by J. H. Wheat, A. E. Murlin, O. G. Taylor, L. R. Ebert, D. H. Watson, and H. S. Leicht, the area mapped being 365 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas E. M. Bandli ran 78 miles of primary levels and established 21 permanent bench marks and C. F. Urquhart and Mr. Bandli ran 57 miles of primary traverse and set 14 permanent bench marks.

The survey of the Pine quadrangle, lying partly in the Wallowa National Forest, Baker County, was continued by G. S. Smith, the area mapped being 460 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this quadrangle D. S. Birkett ran 69 miles of primary levels and established 21 permanent bench marks.

In addition to the regular cooperative topographic work in Oregon, profile surveys of Deschutes and Metolius rivers were made in Crook, Sherman, and Wasco counties, in connection with water-power investigations being carried on by the water-resources branch in cooperation with the State of Oregon. The distance traversed in the Deschutes River survey was 253 miles, in connection with which an area of 48 square miles, included in the Lava, Cline Falls, and Maiden Peak quadrangles, was mapped, for publication on the scale of 1:31,680, with a contour interval of 5 feet. This work was done by A. T. Fowler and O. G. Taylor. For the control of this area Mr. Fowler, D. S. Birkett, and Paul Hegdahl ran 268 miles of primary levels and established 64 permanent bench marks. The Metolius River survey was begun in June, 1912, and included the traversing of 14 miles.

*Utah.*—The resurvey of the Sunnyside quadrangle (a portion of the old Price River quadrangle), in Carbon County, was completed by S. P. Floore, the area mapped being 165 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The revision of the Tintic mining district, covering an area of 12 square miles in Juab and Utah counties, was completed by W. M. Beaman, for publication on the scale of 1:9,600, with a contour interval of 20 feet.

*Washington.*—The Board of Geological Survey of Washington allotted \$13,750 for the continuation of cooperative topographic surveys and the United States Geological Survey allotted a like sum. The survey of the Cedar Lake quadrangle, lying partly in the Snoqualmie and Rainier national forests, King and Pierce counties, was completed by W. O. Tufts, L. R. Ebert, R. B. Kilgore, F. A. Danforth, and E. L. Thomason, the area mapped being 427 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Palisades quadrangle, in Grant County, was continued and that of the Malaga quadrangle, in Grant and Douglas counties, was begun by H. L. McDonald, the area mapped being 130 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Wenatchee quadrangle, lying partly in the Wenatchee National Forest, Douglas County, was begun by Mr. McDonald, the area mapped being 20 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Malaga quadrangle Mr. McDonald ran 16 miles of primary levels and established 5 permanent bench marks. The survey of a portion of the Grays Harbor quadrangle, covering an area of 160 square miles in Chehalis County, was completed by Charles Hartmann, jr., R. R. Randell, and G. L. Hagman, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Grays Harbor quadrangle Mr. Hagman ran 88 miles of primary levels and established 21 permanent bench marks.

A profile survey of Wenatchee River, in Chelan County, was made by Charles Hartmann, jr., and T. H. Moncure, the distance traversed being 119 linear miles, in connection with which 26 square miles were mapped, for publication on the scale of 1:31,680, with contour intervals of 5 and 10 feet. A profile survey of Snoqualmie River, in King County, was made by R. M. La Follette, the distance traversed being 50 linear miles, in connection with which 15 square miles were mapped, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet. A profile survey of Clealum River, in Kittitas County, was made by Mr. Moncure, the distance traversed being 58 linear miles, in connection with which 11 square miles were mapped,

for publication on the scale of 1:31,680, with a contour interval of 5 feet.

In addition to the cooperative work in Washington, the survey of the Mount Rainier National Park, in Pierce County, was continued by G. R. Davis and F. E. Matthes, the area mapped being 141 square miles, for publication on the scale of 1:62,500, with a contour interval of 100 feet. For the control of this area C. F. Urquhart occupied 7 triangulation stations and marked 1.

*Washington-Oregon.*—The survey of the Mount Hood quadrangle (formerly called the Mount Hood special area), in Skamania County, Wash., and Multnomah and Hood River counties, Oreg., was completed by R. M. La Follette, for publication on the scale of 1:125,000, with a contour interval of 100 feet, the work during this season covering an area of 95 square miles in the Washington portion.

*Hawaii.*—Cooperative topographic surveys were continued in the Hawaiian Islands under an arrangement similar to that of the previous fiscal year, the Territory allotting \$15,000 and the United States Geological Survey allotting \$5,000. The survey of the island of Hawaii was continued, the area mapped being 237 square miles, for publication on the scale of 1:31,680, with contour intervals of 10 and 50 feet. This work covered portions of the Hamakua, Kohala, Honomu, Mauna Kea, and Waipio 15-minute quadrangles and was done by C. H. Birdseye, A. O. Burkland, J. M. Rawls, J. H. Ballinger, and Sidney Birdseye. For the control of the Kohala quadrangle Sidney Birdseye ran 19 miles of primary levels and established 3 permanent bench marks, and for the control of the Honomu quadrangle Mr. Burkland ran 5 miles of primary levels and established 1 permanent bench mark.

In addition to the regular cooperative work, a special survey of the area embracing the proposed national park around Kilauea Crater, island of Hawaii, was made by C. H. Birdseye and Mr. Burkland for the Territorial Government, all expenses being borne by the Territory. The area mapped was 44 square miles, for publication on the scale of 1:31,680, with a contour interval of 25 feet. For the control of this area, J. M. Rawls ran 53 miles of precise levels and established 16 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Winkelman, Ariz.; Bakersfield, Ballarat, Bethany, Big Bar, Bishop, Brentwood, Byron Hot Springs, Caliente, Coalinga, Holt, Lida, Monterey, Mount Goddard, Panoche, Stockton, Weaverville, and Woodward Island, Cal.; special map of proposed Kilauea Volcano National Park, Hawaii; Slug Creek and Salmon River, Idaho; Lolo and

Priest Lake, Idaho-Mont.; Deschutes River, Oreg.; Mount Hood, Oreg.-Wash.; Sunnyside and Tintic mining district (revision), Utah; Cedar Lake, Clealum River, Tieton River, and Wenatchee River, Wash.

Progress in the drafting of additional sheets was made as follows: Phoenix, Ariz. (revision), 87 per cent; Long Valley, Cal., 45 per cent; Metz, Cal., 80 per cent; Petaluma, Cal., 32 per cent; Sawyers Bar, Cal., 20 per cent; Soledad, Cal., 98 per cent; Waipio No. 6, Hawaii, 73 per cent; Waipio No. 7, Hawaii, 5 per cent; Hamakua No. 5, Hawaii, 32 per cent; Preuss Range, Idaho, 45 per cent; Henry, Idaho, 20 per cent; Wayan, Idaho, 80 per cent; Washington Creek, Idaho, 13 per cent; Weippe, Idaho, 24 per cent; St. Regis, Idaho-Mont., 30 per cent; Taft, Idaho-Mont., 32 per cent; Quartz, Mont., 5 per cent; Albany, Oreg., 36 per cent; Boring, Oreg., 95 per cent; Brownsville, Oreg., 11 per cent; Cazadero, Oreg., 8 per cent; Corvallis, Oreg., 3 per cent; Lebanon, Oreg., 25 per cent; Monroe, Oreg., 50 per cent; Oregon City, Oreg., 45 per cent; Pine, Oreg., 60 per cent; Malaga, Wash., 48 per cent; Mount Rainier, Wash., 55 per cent; Palisades, Wash., 27 per cent; Snoqualmie River, Wash., 75 per cent; Wenatchee, Wash., 5 per cent; Cispus River, Wash., 30 per cent (field work by water-resources branch).

In the computing section the following computations and adjustments were made:

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Avena, Clyde, Copperopolis, Manteca, Peters, and Trigo quadrangles (Cal.). Primary-level circuits in the Monterey quadrangle (Cal.) were adjusted. Geodetic distances and positions were computed in the Banta, Borax Flat, Byron, Holt, Lathrop, Oakdale, Stockton, Tracy, and Union Island quadrangles (Cal.).

Primary-level circuits were adjusted in the Chatcolet Station, Fernwood, Henry, Kamiah, Kendrick, Soda Springs, Summit Lake, Crags Mountains, Wayan, and Weippe (Idaho), Asotin and Lapwai (Idaho-Wash.), Fish Creek, Pot Mountain, and Taft (Idaho-Mont.), and Freedom, Montpelier, and Preuss Range (Idaho-Wyo.) quadrangles.

Primary-level circuits were adjusted and geographic positions were computed for the Albany, Lebanon, Oregon City, and Reedville quadrangles (Oreg.). Primary-level circuits were adjusted in the Baker City, Birch Creek, Brownsville, Cline Falls, Corvallis, Dufur, Lava, Madras, Maiden Peak, Monroe, Moro, Pine, and Prineville (Oreg.) and Goldendale (Oreg.-Wash.) quadrangles. Geographic positions for the Aumsville, Boring, and Salem quadrangles (Oreg.) were computed.



Primary-level circuits were adjusted in the Cape Elizabeth, Grays Harbor, Humptulips, Palisades, and Point Hanson quadrangles (Wash.). Geodetic distances and positions for the Mount Rainier quadrangle (Wash.) were computed.

#### INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

The field time of the inspectors was divided between inspection duty and special topographic work. J. H. Renshawe spent the season in inspecting the current work of field parties in portions of the Atlantic and Central divisions. W. M. Beaman, after examining and revising the large-scale Tintic mining map, comprising 12 square miles in Juab and Utah counties, Utah, was engaged during the remainder of the field season in the inspection of river surveys and other current topographic work in the Rocky Mountain and Pacific divisions. F. E. Matthes spent the regular field season in topographic work on the map of the Mount Rainier National Park, Wash., completing 51 square miles, and in October spent two weeks in topographic work on the Hanna quadrangle, Wyo. Since January Mr. Matthes has been engaged in office drafting of his field sheet and the preparation of several reports on national parks for publication by the Department of the Interior.

The office duties of Messrs. Renshawe and Beaman involved a careful supervision of the inking and preparation of the final drawings of the topographic branch and their examination prior to submission for engraving or photolithography. Mr. Beaman's duties also included the examination and transmission of land classification, woodland, and other special information, attention to referred matters largely from the editor of topographic maps, and the proper transmission of all original topographic map manuscript.

#### INSTRUMENTS AND TOPOGRAPHIC RECORDS.

As in past years, the repairs to all topographic instruments were made under the supervision of E. M. Douglas, who is also in charge of the topographic records.

The principal instruments repaired in the Survey shop consist of 179 telescopic alidades, 67 Y levels, 10 prism levels, 14 transits, 60 tripods, 240 box compasses, 28 pocket, clinometer, and other compasses, and 30 Locke levels. In addition to these, over 1,700 smaller articles were repaired. The principal repairs made by outside contractors were those to leveling rods, for the repair of which the Survey has no facilities.

The additions to the topographic records consisted of 250 triangulation or primary traverse books, 370 level books, 225 vertical-angle

or stadia books, and 50 plane-table sheets, all of which have been numbered and catalogued.

#### MAP OF THE UNITED STATES.

Of the work in progress last year on the 1:1,000,000 scale map of the United States, under the direction of A. F. Hassan, base maps of the following States have been completed: Alabama (portions of sheets H and I 16), Delaware (portion of sheet J 18), Georgia (portions of sheets H and I 16 and 17), Mississippi (portions of sheets H and I 15 and 16), New Jersey (portions of sheets J and K 18), New York (portions of sheets K 17 and K and L 18), Pennsylvania (portions of sheets J and K 17 and 18), Tennessee (portions of sheets I 15 and I and J 16 and 17), and Wyoming (portions of sheets K and L 12 and 13). These State maps, with portions of other States which have been compiled, complete the bases of the following international sheets: North H 16, North H 17, North I 16, North J 18, and North K 18. Additional work included the lettering of 60 per cent of the base map of Montana (portions of sheets L and M 11, 12, and 13) and the compilation and inking of 35 per cent of sheets I and J 10 (California).

In addition to the work on the 1:1,000,000 scale map, 75 per cent of the contour revision of the three-sheet map of the United States was completed and 33 special maps were prepared for other branches of the Government.

#### WATER-RESOURCES BRANCH.

##### GENERAL SCOPE OF WORK.

The work of the water-resources branch has been continued under the administrative plan described in last year's report. Though the appropriation (\$150,000) was the same as that for the previous year, the scope of the work has been considerably increased in certain sections of the country. This increase has been made possible by additional cooperative moneys allotted by certain States and, in New Hampshire, by the necessity for an intensive hydrometric investigation in the White Mountain area under the authority of the Weeks Act.

##### ALLOTMENTS.

The allotments of the appropriation for the fiscal year were as follows:

Administrative expenses of the Survey-----	\$10,761.67
Clerical assistance -----	5,200.00
Computation, reports, and technical studies-----	9,200.00



## Stream gaging in—

New England and New York.....	\$4, 850. 00
Virginia, South Carolina, North Carolina, Georgia, Alabama, Mississippi, and Tennessee.....	4, 000. 00
West Virginia, Kentucky, Ohio, Indiana, and Illinois..	8, 000. 00
Minnesota.....	10, 000. 00
Texas.....	1, 000. 00
Southern Wyoming, Colorado, and New Mexico....	8, 175. 00
Northern Wyoming, Montana, and North Dakota..	7, 000. 00
Idaho, Utah, and Nevada.....	8, 750. 00
Washington and Oregon.....	12, 000. 00
California .....	5, 580. 00
Nevada and Arizona.....	4, 870. 00
Hawaii.....	5, 000. 00
Investigation of ground waters, including quality of waters .....	17, 500. 00
Land-classification board .....	11, 644. 00
Water-power investigations.....	14, 969. 33
Deschutes River investigation.....	1, 500. 00
	<hr/>
	150, 000. 00

Of the total appropriation 83.5 per cent was allotted for work in the public-land States.

## COOPERATION.

## STATES.

Cooperation with several States has been maintained as described in previous reports. The States and the amounts allotted by them are as follows:

*Amounts allotted by States for cooperative work with United States Geological Survey in investigation of water resources.*

## California :

State engineer .....	\$9, 000
Conservation Commission.....	12, 000
Board of Control .....	4, 000
	<hr/>
	\$25, 000. 00
Colorado .....	167. 10
Hawaii .....	12, 000. 00
Idaho .....	12, 000. 00
Illinois.....	2, 191. 37
Maine.....	1, 350. 00
Minnesota .....	16, 000. 00
Massachusetts .....	1, 000. 00
Montana.....	3, 000. 00
New York :	
State engineer.....	\$1, 500. 00
Water-Supply Commission.....	1, 976. 30
Conservation Commission.....	10, 000. 00
	<hr/>
	13, 476. 30
New Mexico .....	4, 258. 15

## Oregon :

For stream gagings.....	\$8, 419. 47
For analyses of waters.....	2, 000. 00
For Deschutes River investigation.....	3, 000. 00
	<hr/>
	\$13, 419. 47
Tennessee.....	718. 22
Utah.....	2, 521. 47
Vermont.....	1, 000. 00
Washington.....	4, 419. 31
Wyoming.....	200. 00
	<hr/>
	112, 721. 39

The work performed under the cooperative agreements is outlined in the following paragraphs.

*California.*—Three separate agreements have been in effect in California during the year. The first is a continuation of the one that has been in force during previous years, the State cooperating through the office of the State engineer under a continuing authority and appropriation enacted by the California Legislature in 1909. Under this agreement the sum of \$9,000 has been expended by each party and the work has been confined to the maintenance of river-flow measurement stations previously established and a study of the occurrence and availability of underground waters. The second agreement was executed with the Conservation Commission of California, under which the commission allotted to the Geological Survey, for the purpose of establishing and maintaining 60 river-measurement stations, the sum of \$12,500. The work under this agreement was carried on in connection with that provided under the agreement first mentioned. The third agreement was executed with the State Board of Control (Water Powers), under which the board allotted to the Geological Survey the sum of \$4,000 to be used in the preparation of reports containing the results of all hydrometric investigations that have been maintained in the State since the beginning of the work there. The preparation of these reports was nearly completed at the end of the fiscal year.

*Colorado.*—Cooperation in Colorado was maintained through the office of the State engineer, who assumed the cost of maintaining certain flow-measurement stations, the total contribution being given in the foregoing table.

*Hawaii.*—The cooperative work in Hawaii, under an agreement executed by the Geological Survey and the Territorial government, consisted of the determination of stream flow, the measurement of precipitation, and incidental studies of water losses occasioned by seepage in irrigation canals. The sum of \$5,000 was allotted by the Geological Survey and \$12,000 by the Territory.

*Idaho.*—Two cooperative agreements between the Geological Survey and the Idaho State Land Board have been in force during the

year. The first, executed on July 1, 1911, provided for the expenditure of \$5,000 by each party in the maintenance of stream-flow investigations. Owing to the increasing importance of the investigations in Idaho, the State was made a separate district of the Survey on September 1, 1911, and a new agreement was made covering the period between that date and January 1, 1913, under which the Geological Survey agreed to allot the sum of \$8,600 and the State the sum of \$11,350.

*Illinois.*—The cooperative work in Illinois has consisted of the maintenance of stream-flow measurement stations under the joint direction of the Geological Survey and the Rivers and Lakes Commission of Illinois. All the expenses of this work except those for supervision, computations, and publication of results have been borne by the State, the amount expended by it being \$2,200.

*Maine.*—Under a cooperative agreement with the Maine State Water Storage Commission the sum of \$1,350 was allotted for the maintenance of stream-flow measurements during the fiscal year.

*Massachusetts.*—A cooperative agreement between the Geological Survey and the governor of the Commonwealth of Massachusetts executed on January 2, 1912, provided that between that date and June 30, 1912, each party should contribute the sum of \$1,000 for the measurement of the flow of streams within the Commonwealth.

*Minnesota.*—The Minnesota State Drainage Commission has cooperated with the Geological Survey during the fiscal year in the maintenance of stream-flow measurements and the survey of river profiles. The amount allotted by the commission was \$16,000 and by the Survey \$10,000.

*Montana.*—Cooperation was maintained between the Geological Survey and the Carey Land Act Board of Montana, under which each party expended the sum of \$3,000 in the maintenance of stream-flow measurements.

*New Mexico.*—Cooperation with New Mexico has consisted in the payment of certain expenses by the State engineer. It involved the maintenance of stream-flow measurement stations previously established. The amount expended by the Geological Survey was \$2,500 and by the State \$4,258.

*New York.*—Two cooperative agreements were in force in New York, one with the State engineer and the other with the New York Conservation Commission and its predecessor, the Water-Supply Commission. The work was confined to the determination of stream flow for the purpose of municipal supply, development of water power, and flood prevention. The amount expended by the Geological Survey was \$2,500, by the State engineer \$1,500, and by the Conservation Commission \$10,000.

*Oregon.*—The cooperation in Oregon, arranged with the office of the State engineer, consisted of three agreements—first, for the determination of stream flow; second, for a complete survey and investigation of the water powers of Deschutes and Metolius rivers; and, third, for an investigation or survey of the chemical composition of the river waters of the State for the purpose of determining their utility in municipal, agricultural, and manufacturing uses.

*Tennessee.*—Under an agreement with the State geologist of Tennessee a survey and stream-flow investigation of Doe River was begun for the purpose of making a report on the available water power of that stream. The expenditure by the State was \$718.22, that by the Geological Survey was \$254.54, and the difference will be expended during the present field season by the Survey to the end that the cost of the investigation may be equally divided between the two parties.

*Utah.*—The cooperative work carried on in conjunction with the State engineer of Utah during previous years, under which investigations were made of stream flow for use in irrigation and the development of water power, was continued during the past year, each party contributing the sum of \$2,500.

*Vermont.*—The cooperative work in Vermont consisted of the determination of stream flow, and under the agreement executed by the Geological Survey and the governor of the State each party contributed the sum of \$1,000.

*Washington.*—The cooperative work in Washington was in continuation of that maintained during previous years under an agreement executed by the governor, providing for investigation of stream flow for use in irrigation and the development of power and the preparation of reports on the water powers of the Cascade Range in conjunction with profile and reservoir surveys made by the topographic branch under a separate agreement.

*Wyoming.*—The State engineer of Wyoming and the Geological Survey have each expended the sum of \$200 in the maintenance of stream-flow measurement stations within the State.

#### RECLAMATION SERVICE.

Under the direction of the Reclamation Service and at the expense of the reclamation fund 131 stations have been maintained on Government irrigation projects by the Geological Survey. The arrangement for this work was the same as that described in the report for the fiscal year ended June 30, 1911.

#### OFFICE OF INDIAN AFFAIRS.

A large amount of work has been performed by the water-resources branch at the request of the Commissioner of Indian Affairs in con-

nection with the classification of lands within Indian reservations with regard to water powers and reservoir sites. The following is a detailed statement of the work so performed:

*Blackfeet Reservation.*—An investigation of the power and reservoir-site possibilities of the Blackfeet Reservation was made under an allotment of \$350. The report was completed and filed on July 31, 1911, at a cost of \$147.75.

*Camp McDowell Reservation.*—An investigation in the Camp McDowell Reservation was performed under authority dated July 18, 1911, the allotment being \$75. The report was filed March 21, 1912, the investigation being made at a total cost of \$102.55.

*Colville Reservation.*—An investigation of the water-power and reservoir-site possibilities of the Sanpoil and Nespelem River basins was performed under authority dated April 11, 1911, the allotment being \$500. The report thereon was filed September 27, 1911, the cost being \$498.80. Under a second authority, dated November 24, 1911, a similar investigation was made of that portion of the Colville Reservation not covered by the investigation above mentioned, under an allotment of \$150. The report was filed June 4, 1912, and the cost of the investigation was \$99.90. In addition to the foregoing work the sum of \$350 was allotted November 24, 1911, to be used in the maintenance of stream-flow investigations on the Colville Reservation up to June 30, 1912.

*Crow Reservation.*—Under authority dated March 30, 1911, an investigation of the Crow Reservation was made for the purpose of locating and establishing suitable river-flow measurement stations, the allotment therefor being \$110. A report on this investigation was filed November 2, 1911, the cost of the work being \$138.30. Under a further authority, dated November 29, 1911, the sum of \$550 was allotted for the maintenance of stations established under the previous investigation, up to June 30, 1912.

*Fort Hall Reservation.*—Under an agreement dated February 25, 1911, the sum of \$1,000 was allotted for the maintenance of river-flow measurement stations established in the Fort Hall Reservation under a previous agreement. Under further authority, dated July 1, 1911, the sum of \$226 was allotted for an investigation of water-power and reservoir-site possibilities on the reservation. The report on this investigation was filed August 10, 1911, the cost thereof being \$203.19.

*Fort Peck Reservation.*—An investigation of water-power and reservoir-site possibilities in the Fort Peck Reservation was authorized on August 4, 1911, the allotment therefor being \$300. The report was filed November 7, 1911, the total cost of the work being \$34.20.

*Gila River Reservation.*—Under an allotment of \$100, dated September 8, 1911, an investigation of water-power and reservoir-site possibilities was made in the Gila River Reservation. The report was filed March 21, 1912, the total cost of the work being \$113.72.

*Klamath Reservation.*—The Commissioner of Indian Affairs authorized, on March 30, 1911, the expenditure of \$350 for the maintenance during the period ending June 30, 1912, of gaging stations established in the Klamath Reservation under a previous agreement. On March 30, 1911, the sum of \$50 was allotted for a further reconnaissance of the Klamath Reservation for the purpose of locating and establishing additional gaging stations required in connection with the land-classification work. The report on this investigation was filed February 13, 1912, the cost of the work being \$26.95. Under date of March 6, 1912, a further allotment of \$300 was authorized for the maintenance of these stations up to June 30, 1912. An investigation of water-power and reservoir-site possibilities on this reservation was authorized October 12, 1911, the allotment therefor being \$200. A report was filed October 20, 1911, at an expense of \$49.95. The report was not acceptable, and a further investigation will be made during the present field season.

*Menominee Reservation.*—The maintenance of flow-measurement stations established in the Menominee Reservation under previous authority of the Office of Indian Affairs was continued during the past year under an allotment of \$600 made on January 1, 1912.

*Moki and Navajo reservations.*—The work on the Moki and Navajo reservations consisted of investigations of the occurrence and availability of underground waters in continuation of a previous authority and a special allotment of \$1,500 authorized by the Commissioner of Indian Affairs March 30, 1911.

*Pine Ridge Reservation.*—An investigation of water-power and reservoir-site possibilities in the Pine Ridge Reservation was authorized on February 20, 1912, under an allotment of \$500. A report was filed June 11, 1912.

*Quinaelt Reservation.*—The work in the Quinaelt Reservation consisted of two parts. An investigation of water-power and reservoir-site possibilities was authorized September 14, 1911, under an indefinite allotment. A report was filed December 13, 1911, the cost of which was \$139.22. In addition the Acting Commissioner allotted on January 19, 1912, the sum of \$50 for the maintenance of a river-flow measurement station on the reservation.

*Rosebud and Pine Ridge reservations.*—An allotment of \$225 was authorized on March 20, 1911, for the reconnaissance and establishment of river-flow measurement stations in the Rosebud and Pine Ridge reservations. A report thereon was filed October 21, 1911, the cost of which was \$261.91. The maintenance of the stations, estab-



lished at a cost to June 30, 1912, of \$490, was authorized November 24, 1911.

*Rosebud Reservation.*—An investigation of water-power and reservoir-site possibilities in the Rosebud Reservation was authorized on August 4, 1911, and the report filed October 21, 1911. The allotment for this work was \$100, and the ultimate cost \$98.50.

*Salt River Reservation.*—Under authority granted September 8, 1911, an examination of the Salt River Reservation for water-power and reservoir-site possibilities was undertaken under an allotment of \$100. A report was filed on March 21, 1912, the total cost thereof being \$102.52.

*Standing Rock Reservation.*—Under authority dated March 30, 1911, a reconnaissance of the Standing Rock Reservation for the purpose of locating and establishing stream-flow measurement stations was made during August and September, 1911, the allotment therefor being \$150. A report was filed on October 21, 1911, the total cost of which was \$103.76. Under date of November 24, 1911, an allotment of \$350 was authorized for the maintenance to July 1, 1912, of the stations established under the foregoing investigation. A further investigation relative to water-power and reservoir-site possibilities was made under an allotment of \$200, dated October 12, 1911. Report on this investigation was filed October 21, 1911, the ultimate cost thereof being \$137.71.

*Warm Springs Reservation.*—On March 28, 1911, the Commissioner of Indian Affairs authorized a reconnaissance of the Warm Springs Reservation for the location and establishment of stream-flow measurement stations. The work was performed in June, 1911, and a report filed October 12, 1911. The allotment for this investigation was \$60 and the ultimate cost \$60.40. Under date of February 12, 1912, an allotment of \$452 was authorized for the maintenance of the stations established until July 1, 1912. An investigation of water-power and reservoir-site possibilities on this reservation was begun under authority dated March 16, 1912, the allotment therefor being \$400. The field work in this investigation was performed during the month of June, 1912, but no report thereon was received until the close of the fiscal year.

*Yakima Reservation.*—The work in the Yakima Reservation consisted of the maintenance of stream-flow measurement stations established under previous authority. The allotment authorized for the fiscal year on March 30, 1911, was \$850.

#### FOREST SERVICE.

Cooperation with the Forest Service, described in the report for the fiscal year 1911, was continued during the past year. The num-



ber of stations maintained under this arrangement exceeds that for the previous year and is as follows:

*Stream-gaging stations in national forests.*

California -----	62	Oregon -----	19
Colorado -----	61	Utah -----	16
Idaho -----	20	Washington -----	18
Montana -----	18	Wyoming -----	12
New Mexico -----	7		

PUBLICATIONS.

The work of the water-resources branch is represented by the following publications issued during the year:

Bulletin 479; Water-Supply Papers 261, 266 to 269, 271 to 280, 282, 285 to 288, and 295. Titles and brief summaries of these publications are given on pages 29, 34-36. Water-Supply Papers 259, 283, 284, 289 to 294, 296, 298, 301, 304, and 311 were at the Government Printing Office at the close of the year. Seven manuscripts are in hand awaiting editorial work and 21 reports are in different stages of preparation. Reprints of the following water-supply papers, the original edition of which has been exhausted, were delivered during the year: 170, 172, 173, 174, 200, 201, 202, 203, 204, 206, 207, 208 (two reprints), 209 (two reprints), 210, 211, 213, 214 (two reprints), 219, 231, 232, 247, 248, 249, 255 (two reprints), 257, and 273. Bulletin 479 has also been reprinted.

DIVISION OF SURFACE WATERS.

ORGANIZATION.

The principal work of the division of surface waters consists of the measurement of the flow of rivers. In carrying on this work the United States has been divided into 15 districts, including Hawaii and Alaska.

In each district is maintained a central office under the supervision of a district engineer, with a corps of assistants. The following list gives the districts, the territory covered, and the district engineer and his headquarters:

Maine district, covering only the State of Maine. C. C. Babb, district engineer, State Capitol, Augusta, Me.

New York and New England district: New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and New York. C. C. Covert, district engineer, Federal Building, Albany, N. Y.

Middle Atlantic district: Maryland, Virginia, and New Jersey. R. H. Bolster, district engineer, Washington, D. C.

Southeastern district: Alabama, Georgia, Mississippi, North Carolina, South Carolina, and Tennessee. M. R. Hall, district engineer, Post Office Building, Atlanta, Ga.

**Ohio Valley district:** Illinois, Indiana, Iowa, Kentucky, Michigan, North Carolina, Ohio, Tennessee, Virginia, West Virginia, and Wisconsin: A. H. Horton, district engineer, Federal Building, Newport, Ky.

**Upper Mississippi district:** Minnesota and Wisconsin. W. G. Hoyt, district engineer, Old Capitol Building, St. Paul, Minn.

**Upper Missouri district:** Montana, North Dakota, and Wyoming. W. A. Lamb, district engineer, Montana National Bank Building, Helena, Mont.

**Denver district:** Colorado, Nebraska, New Mexico, South Dakota, and Wyoming. Robert Follansbee, district engineer, Chamber of Commerce Building, Denver, Colo.

**Great Basin district:** Utah, Wyoming, and Nevada. E. A. Porter, district engineer, Brooks Arcade, Salt Lake City, Utah.

**Idaho district,** covering only the State of Idaho. G. Clyde Baldwin, district engineer, Idaho Building, Boise, Idaho.

**Columbia River district:** Oregon and Washington. F. F. Henshaw, district engineer, Tilford Building, Portland, Oreg.

**California district:** California, Nevada, and Arizona. H. D. McGlashan, district engineer, Custom House, San Francisco, Cal.

**Texas district,** covering only the State of Texas. T. U. Taylor, district engineer, Austin, Tex.

**Hawaiian district,** covering the Territory of Hawaii. W. F. Martin, district engineer, Honolulu, Hawaii.

**Alaskan district,** covering the Territory of Alaska. C. E. Ellsworth, engineer in charge.

The results of the work performed in the several districts are analyzed in the respective district offices and are then transmitted to the Washington office, where they are reviewed and prepared for publication in the computing section, which is under the charge of R. H. Bolster, hydraulic engineer. The work of the computing section is important, as its examinations insure that the data are on a high standard and that they are presented in a uniform manner. This division also carried on special hydrologic studies, the results of which are published in special water-supply papers.

#### **GAGING STATIONS AND COOPERATING PARTIES.**

For making measurements of stream flow regular points of measurement, known as gaging stations, are established on the various streams. At these points sufficient data are collected for determining the daily flow. The distribution of the gaging stations by States is shown in the accompanying table, together with the number of stations established and discontinued. As a large part of the work is carried on in cooperation with other Federal bureaus, State organizations, and private parties, the table has been arranged to show the extent of such cooperation in each State. During the year 99 stations were discontinued and 278 stations established. At the end of the year the total number of stations maintained, exclusive of those in Alaska and Hawaii, was 1,232. In addition to the foregoing, records ready for publication for about 186 stations were received at the end of the year from private parties.

*Gaging stations maintained by United States Geological Survey and cooperating parties at end of fiscal year 1911.*

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Records for 186 stations are obtained and furnished complete by outside parties.

During the past year special attention has been given to improvement in the accuracy of the results obtained. In this connection much new equipment has been installed, including many automatic gages for obtaining a continuous record of stage, which is necessary to determine accurately the daily flow of streams that have much diurnal fluctuation in stage. The methods in use in the Washington office and in the district offices were thoroughly reviewed, and standard methods of procedure in all lines of work were installed in all the offices, thereby increasing the efficiency and also raising the standard of the results.

In Alaska investigations were carried on in the Fortymile, Circle, and Fairbanks regions.

Sufficient data were collected in connection with the investigations in the Territory of Hawaii for publication in a report, which is *now being prepared*.

PUBLICATIONS.

To facilitate the use of Government reports relating to water supply, climate, and related subjects the United States has, by agreement between the Geological Survey and the Weather Bureau, been divided into 12 areas, and the progress report of stream gaging has been divided into 12 parts, each part covering one of these areas. The areas and the number of the corresponding reports giving the results for 1909, 1910, and 1911 are shown in the table below. The reports for 1911 have not yet been published.

*Reports on surface-water supply of the United States.*

[The numbers given are the serial numbers of the water-supply papers.]

	1909	1910	1911
North Atlantic coast.....	261	281	301
South Atlantic coast and eastern Gulf of Mexico.....	262	282	302
Ohio River basin.....	263	283	303
St. Lawrence River basin.....	264	284	304
Upper Mississippi River and Hudson Bay basins.....	265	285	305
Missouri River basin.....	266	286	306
Lower Mississippi River basin.....	267	287	307
Western Gulf of Mexico.....	268	288	308
Colorado River basin.....	269	289	309
Great Basin.....	270	290	310
California.....	271	291	311
North Pacific coast.....	272	292	312

RIVER-PROFILE SURVEYS.

During the year all river-profile surveys were performed by the topographic branch, except certain incidental surveying in the upper Mississippi district by W. G. Hoyt on Zumbro, Little Fork, Big Fork, Wild Rice, Prairie, and Kawishiwi rivers and on certain rivers draining into Lake Superior.

DIVISION OF GROUND WATERS.

The allotment for the work of the division of ground waters was \$17,630. Of this amount, \$12,570 was used for investigations of ground-water problems and \$5,060 for investigations of the quality of water, including both surface and underground supplies.

An investigation of the underground water resources of the State of Connecticut was undertaken at the beginning of the fiscal year in cooperation with the State Geological and Natural History Survey. This investigation, which is to be extended over a period of two or more years, is under the supervision of Prof. H. E. Gregory, of Yale University and of the Survey staff, and the field work is conducted by A. J. Ellis, of the Geological Survey. It is one of the most detailed studies of ground water that has been undertaken in any of the Eastern States, and it will furnish the basis for a reliable estimate of the quantity of ground water available to the rapidly developing industrial communities of Connecticut.

A comprehensive report on the underground water of Iowa, which has been for some time in preparation in cooperation with the State Survey, was received in rough draft late in the previous fiscal year, has been advanced through the various stages of editorial revision, and is now in the hands of the Public Printer. This report (Water-Supply Paper 293) has been prepared under the supervision of Prof. W. H. Norton, of Cornell College, Mount Vernon, Iowa, and will be published as a joint product of the Federal and State surveys.

A report by Prof. C. H. Gordon, of the University of Tennessee, Knoxville, Tenn., on the geology and underground waters of north-eastern Texas, was issued during the present fiscal year as Water-Supply Paper 276, and a similar report by the same author on the geology and underground waters of the Wichita region of north-central Texas (Water-Supply Paper 317) is now in the hands of the editor.

During the last few years the Geological Survey has made a series of investigations of the underground water resources and irrigation possibilities of the western half of Utah, in which numerous shallow-water tracts exist. The results of these investigations have been published in several water-supply papers, the report by O. E. Meinzer on the ground waters in Juab, Millard, and Iron counties having been issued during the present fiscal year as Water-Supply Paper 277. In July, 1911, the examination of Boxelder County, a part of Tooele County, and certain small areas in southern Idaho was undertaken by Everett Carpenter, junior geologist, and at the close of the fiscal year the report is well advanced.

Urgent requests have in recent years been made of the Survey for information as to the occurrence of underground supplies in various parts of New Mexico and the feasibility of utilizing such supplies for irrigation. To these requests the Survey has responded so far as was possible. During the present fiscal year a report by O. E. Meinzer on the geology and water resources of Estancia Valley and adjacent areas was issued as Water-Supply Paper 275, the field investigation of the area about Deming was practically completed, and a survey of the Tularosa Basin and some of the plateaus of central New Mexico was begun. The Deming investigation, which was begun in the previous year, has been conducted by N. H. Darton, geologist, whose report is now in preparation. The Tularosa survey is being made in cooperation with the New Mexico Agricultural Experiment Station, O. E. Meinzer being in charge of the work done by the Federal Survey and Dr. R. F. Hare, chief chemist of the Experiment Station, being in charge of the analytical work done by the State. The report that is being prepared will cover all important phases of the underground-water problems of the region but will be devoted especially to the problems of irrigation with ground water in the Tularosa Basin *and of the development of supplies for range stock on the plateaus.*

It will also contain a guide to desert watering places in a part of New Mexico.

The report on the geology and water resources of Sulphur Springs Valley, Ariz., produced in collaboration by O. E. Meinzer, of the Federal Survey, and R. H. Forbes and F. C. Kelton, of the State Experiment Station, has been completed during the present fiscal year. It will be issued both as a water-supply paper of the Survey and as a bulletin of the Arizona Experiment Station.

The special investigations which during the preceding two years were conducted for the Office of Indian Affairs in the Moki and Navajo reservations in Arizona and adjacent parts of New Mexico and Utah were continued during the present year by H. E. Gregory, who has from the beginning been in charge of the work. The results of these studies are not prepared for publication but are presented in the form of manuscript reports to the Commissioner of Indian Affairs and serve as guides to the agents and engineers of the Indian Office.

By direction of Assistant Secretary Thompson, W. C. Mendenhall was instructed on August 3, 1911, to visit the Mesa Verde National Park, in order to examine the water supplies developed and available there for the use of the park officials and tourists and to suggest, should there prove to be need of additional supplies, methods for their development. The examination was made in the early part of September, 1911, and a report embodying its results has been prepared.

Reports embodying the results of four independent underground water investigations in California are in process of preparation or publication. Extensive field investigations of the occurrence, quality, and recovery of the underground supplies of the great area known as the San Joaquin Valley were made previous to this fiscal year by W. C. Mendenhall, geologist in charge of underground-water investigations, R. B. Dole, and Herman Stabler. During the year 1911-12 the data thus acquired have been reduced in the office, and a report for publication has been written in part. A similar report on the San Jacinto Valley is in preparation. On account of the importance of the underground supplies for irrigation the results of these two investigations will be of exceptional value.

The report by G. A. Waring on California springs and the report by C. H. Lee on an intensive study of the water resources of a part of Owens Valley, Cal. (Water-Supply Paper 294), have both been completed during the present year and will be published in the near future. The researches in Owens Valley were made possible through the cooperation of the city of Los Angeles. The results obtained will be a valuable contribution to the knowledge of the laws governing the circulation and disposal of underground waters.

A special investigation of the effects of steps taken by certain southern California communities during recent years to measure the



absorption of flood waters and thereby add to the ground-water supplies has recently been undertaken by Mr. Lee, through cooperation with the California State Conservation Commission. This research will be continued during the year 1912-13.

The underground-water investigations on the Atlantic and Gulf Coastal Plain are conducted by the geologic branch in connection with other geologic work and are described elsewhere in this report.

Investigations of the quality of water were continued under the immediate direction of R. B. Dole, chemist. He devoted the first ten months of the year to the preparation of a report on the quality of surface waters of the United States and of sections of other reports of the Survey as follows: "The concentration of mineral water in relation to therapeutic activity," for the chapter of "Mineral resources" on the production of mineral waters in 1911; and chapters on the quality of underground waters for reports on the underground-water resources of Texas, Florida, Georgia, Mississippi, and California. During May and June Mr. Dole was transferred to the geologic branch for the purpose of making a field examination of potash deposits in the southwestern part of Nevada. He also retained supervision over the work of Walton Van Winkle, assistant chemist, in Oregon.

Walton Van Winkle was engaged in an investigation of the quality of surface waters in Oregon and their availability for use for household, agricultural, and manufacturing purposes. This work was maintained in cooperation with the State of Oregon, through the office of John H. Lewis, State engineer, and consisted of the analysis of samples of water taken daily at the regularly established sampling stations on the important streams of the State. The laboratory work was performed in suitable quarters gratuitously furnished by the Willamette University at Salem, Oreg.

#### DIVISION OF WATER UTILIZATION.

##### ORGANIZATION.

The work of the division of water utilization has been maintained under the general plan of organization described in the last annual report. E. C. LaRue and E. C. Murphy, engineers, have performed the greater portion of the field work involved in the examination of water-power withdrawals, rights of way, Carey Act segregations, and enlarged-homestead designations and the examination of lands for similar purposes within Indian reservations. The chief hydrographer has expended such portion of his time as could be spared from other duties in similar field work. The personnel of this division and the appropriation available for its work are entirely insufficient to meet suitably the demands made upon it. A discussion of *the scope of the work and its condition on January 1, 1912, so far as*



the field investigations are concerned, is contained in the following paragraphs.

#### CLASSIFICATION OF PUBLIC LANDS.

The enlarged-homestead acts of February 19, 1909, and June 17, 1910, and the withdrawal act of June 25, 1910, involve extensive field investigations and reports by the Geological Survey. Contemporaneous with these duties came the Secretary's policy of referring to the Survey for report applications for rights of way and for Carey Act segregations. This policy requires work nearly if not quite as extensive as that imposed by the two acts above referred to. In these ways there were thrown on the water-resources branch field duties which, if suitably performed, would more than double the work that was being previously done. Nevertheless an increase of \$50,000 only has been granted to meet this new condition. It should be emphasized that all the Land Office work involving the determination of the suitability of lands for water power and irrigation falls upon this appropriation. In consequence of the lack of funds the work is far behind schedule, and that which has been done has not been performed as well as it should have been. It involves the establishment and maintenance of stream-flow stations as well as engineering investigations of a high character. The enlarged-homestead act, for example, places upon the Survey the determination of the practicable irrigability of land proposed for designation under the terms of the act. To determine this matter properly months of investigation are sometimes necessary. Private companies and the Reclamation Service have spent large sums of money to determine the irrigability of a single tract. The Reclamation Service has found it necessary to expend \$217,000 for the purpose of ascertaining that five irrigation projects, covering 480,000 acres, were not feasible. Under the present conditions the Survey must make such determination on mere inspection, and there is danger that grievous errors may be made. Below is a statement of the status of the public-land classification work, so far as it relates to water utilization. It will be seen that at the present rate of progress the work as a whole is at least two years, and possibly three years, behind, which means that unless any recent application is taken up out of its regular order it can not be finally acted upon by the department inside of three years.

#### *Enlarged-homestead designations in fiscal year 1912.*

Designated during the year.....	acres..	1, 700, 000
After field examination.....	do....	613, 000
From office data .....	do....	857, 000
From general information.....	do....	230, 000
Petitions now pending.....		200
Area represented.....	acres..	2, 000, 000

As the boundaries of the designated areas are extended and refined the requests for examination and designation refer to smaller and more scattered areas, and the difficulty and expense of making the necessary investigations proportionately increase. Many of the tracts adjoin irrigable areas, and the determination of the character of the lands with respect to future irrigation requires much more careful investigation than was necessary in the earlier cases.

It is estimated that the examination of the area now on application, comprising about 80 townships, will require the work of two engineers for an entire field season. The office work of preparing the results for action and the making of proper records will require the entire time of one clerk, in addition to technical supervision.

*Right-of-way applications.*

Pending in Survey January 1, 1911-----	239
Received from General Land Office-----	834
Reported on during 1911-----	861
From office data-----	791
From field examination-----	90
Applications pending in field-----	89

These figures indicate that a little over 10 per cent of the applications received have been given special field examination. The other 90 per cent were reported upon from office information obtained from reports upon previous applications, from investigations of water-power withdrawals, or from topographic and water-supply data on file. Although the land-classification board might properly call for a field examination on many of these applications, such examination has not been requested, because of the knowledge that only a small number of applications could be promptly examined in the field. Action has thus been taken on meager data in many cases where it is probable that field investigation should have been made.

The number of applications pending report from the field at the close of the calendar year does not represent the accumulation of work of this character at the present time. It is believed that important data would be procured on over 50 per cent of the 212 applications pending on January 1, 1912, if field examination were possible. The 89 applications pending report from the field thus by no means represent the amount of field work which should be done during the coming field season.

About 150 right-of-way applications now pending require field investigations. They represent fully a year's work for four men. About one-half the time of two men is now employed, and no more can be assigned without a larger appropriation. At this rate the applications now pending can not all be acted on for at least four years.

*Water-power withdrawals.*

	Acres.
Withdrawn and requiring examination Jan. 1, 1911-----	1, 149, 618
Examined during 1911-----	398, 330
Remaining unexamined -----	751, 288
New withdrawals during 1911-----	358, 445
Of which there must be examined-----	223, 939
Grand total awaiting examination-----	975, 227

This work will require at the present rate of progress two and one-half years to complete.

**CAREY ACT SEGREGATION LISTS.**

The reclamation of public lands by the States under the terms of the Carey Act and its amendments requires investigation by the Geological Survey to determine the sufficiency of the water supply and the feasibility of the plan of reclamation. There are ordinarily three stages in the development of a project—first, the temporary blanket withdrawal for one year of an area believed to include all the lands that will eventually be segregated for the project, in order that the State may work out a detailed plan of irrigation; second, the segregation of the irrigable lands for a period of 10 years in order that the irrigation works may be constructed and the lands reclaimed and settled; and third, the application of the States for patent, the lands having been reclaimed in accordance with the contract entered into at the time of segregation.

During the period of temporary withdrawal it is occasionally desirable that the project be examined in a general way in order to determine what steps are being taken to procure data by which to estimate the water supply available for the project. The necessity for field investigation arises, however, in most projects, in connection with the segregation of the lands. Here the determination of the acreage which the project may properly include requires a careful study of the water supply, water rights, and duty of water. In some projects where accurate stream measurements and records of appropriation are available, field investigation for this purpose is not essential, but where it is proposed to utilize sources of water supply which have not been accurately measured, or where the water rights are chaotic, examination on the ground is essential to the protection of the prospective settlers. Lastly, there must be an examination of the constructed project and a determination of the compliance of the State with the terms of its contract.

A necessity for field investigation arises also when a segregation becomes inactive because of the failure or suspension of the proposing company. In such cases the hardship falls upon the settlers, and the protection of their rights and those of the United States becomes a matter of the highest consequence.

During the calendar year 1911 the Geological Survey reported on the sufficiency of the water supply of 38 proposed segregations, the office work requiring the greater part of the time of an experienced engineer. In addition, field engineers were from time to time detailed to investigate particular projects, and more such investigations would have been requested if it had not been known that great delays in the handling of the cases would have resulted. Since the consideration of the Carey Act lists has been made "special," by order of the Secretary, the land-classification board has found it necessary to act from office information in every case where the information was not so meager as to make such action entirely impossible.

#### ACQUISITION OF LANDS FOR NATIONAL FORESTS.

The investigations of precipitation and run-off, begun near the close of the fiscal year 1911 in the White Mountain region of New Hampshire, have been continued throughout the year, and a preliminary report favorable to the purchase of lands in that region under the terms of the Weeks Act was rendered about June 1. Reference to that report is made elsewhere (pp. 18-19). These investigations were the most intensive that have ever been performed by the Geological Survey and it is doubtful if the features of the run-off of any stream have ever been studied with so much detail as were those that were selected for study in the White Mountain region. The work involved a refined determination of precipitation, in the form of both rain and snow, by the establishment and close observation of numerous gages set on the drainage areas at all different points of elevation and exposure. The studies of run-off were made by the careful establishment and equipment of gaging stations on the several streams and the correction of the channel at those stations in order that extreme refinement might be secured in the measurements of flow. All stations thus established were equipped with automatic recording gages, so that it has been possible to determine the volume of water passing the stations at any moment of the day. The prosecution of the work has made necessary the employment of a corps of engineers numbering at different times from four to eight and of an equal number of observers, whose duties were to make frequent records of precipitation as measured by the numerous gages.

**PUBLICATION BRANCH.****BOOK-PUBLICATION DIVISION.****SECTION OF TEXTS.**

The publications of the year consisted of 1 annual report, 1 monograph, 4 professional papers, 48 bulletins, 34 separate chapters from 5 bulletins, 21 water-supply papers, 2 annual reports on mineral resources (one published also in 54 separate chapters, all delivered in 1910-11, and the other in 51 separate chapters, 7 delivered in 1910-11 and 44 in 1911-12), 20 advance chapters from the annual report on mineral resources for 1911, 6 geologic folios, 2 lists of publications, 57 press bulletins, 12 monthly lists of new publications, one pamphlet entitled "Instructions to topographers of the United States Geological Survey," charts showing mineral and clay products and the production of coal in the United States to the close of 1910, and a circular concerning geologic folios. These publications were the Thirty-second Annual Report; Monograph LII; Professional Papers 69, 70, 73, and 75; Bulletins 448, 450, 451, 454 to 456 inclusive, 458, 464, 466 to 470 (published also in 11 advance chapters, 7 delivered in 1910-11 and 4 in 1911-12) inclusive, 4 advance chapters from 471, 472 to 479 inclusive, 480 (published also in 10 separate chapters), 481 to 497 inclusive, 499, 500, 504 to 507 inclusive, 509, 511, 512, 3 advance chapters from 520, and 13 advance chapters from 530; Water-Supply Papers 261, 266 to 269 inclusive, 271 to 280 inclusive, 282, 285 to 288 inclusive, and 295; Mineral Resources for 1909 (volume), Mineral Resources for 1910 (volume and 44 separates), and 20 advance chapters from Mineral Resources for 1911; Geologic Folios 178 to 183 inclusive; Lists of Publications, New Series Nos. 1 and 2; Press Bulletins 8 to 62, inclusive (also 2 special issues); and Monthly Lists of New Publications Nos. 44 to 55 inclusive. Titles and summaries of the publications of the regular series are given on pages 23-38.

The total number of printed pages in these publications was 17,846. The publications of the previous year comprised 13,566 pages.

During the year 48,210 pages of manuscript were edited and prepared for printing, and proof sheets for 15,677 final printed pages were read and corrected, this work involving the handling of 5,648 galley proofs and 30,513 page proofs. The corresponding figures for 1910-11 were 40,648 pages of manuscript, 17,417 final printed pages, 5,787 galley proofs, and 32,706 page proofs. Indexes were prepared for 49 publications, covering 10,571 pages; the figures for the previous year were 74 publications and 14,400 pages.

At the close of the fiscal year seven persons were employed in this section. The water-resources branch has continued to render special assistance in copy preparing and proof reading.

## SECTION OF ILLUSTRATIONS.

The personnel of the section of illustrations consisted of 10 draftsmen (including the draftsman in charge), 1 assistant map printer, and 1 draftsman-clerk.

During the year 5,006 illustrations were prepared and most of them were transmitted, to accompany 26 bulletins, 11 water-supply papers, 2 professional papers, 1 annual report, and 1 report on mineral resources. These illustrations included 251 maps, 1,679 diagrams, 2,237 paleontologic drawings, 9 landscape drawings, 504 photographs retouched, and 326 miscellaneous pieces.

The section received and compared critically 1,331 proofs, as well as all contract-printed illustrations delivered at the Government Printing Office.

The number of electrotypes furnished to outside applicants was 144.

At the close of the year material for the illustration of 28 reports was on hand, 23 being from 10 to 90 per cent completed.

## SECTION OF MAP EDITING.

## GEOLOGIC MAPS.

The geologic map of North America was completed and issued during the year. Six folios (Nos. 178 to 183, inclusive), which are listed on page 37, were published. The Apishapa (Colo.), Kenova (W. Va.-Ky.-Ohio), Murphysboro-Herrin (Ill.), and Raritan (N. J.) folios were completed with the exception of the descriptive text. The Barnesboro-Patton (Pa.), Ellijay (Ga.-N. C.-Tenn.), Philipsburg (Mont.), and Tallula-Springfield (Ill.) folios were well advanced in publication, and the Belleville-Breese (Ill.), Colorado Springs (Colo.), Eureka Springs-Harrison (Ark.), and San Francisco (Cal.) folios were begun.

The Castle Rock (Colo.), Berea-Cleveland (Ohio), Columbus (Ohio), Eastport (Me.), Minneapolis-St. Paul (Minn.), Niagara (N. Y.), and Silver City (N. Mex.) folios were awaiting editing at the close of the year.

The list of folios in course of publication and in preparation for publication, arranged in order of progress, is as follows:

Kenova, W. Va.-Ky.-Ohio (No. 184).  
Murphysboro-Herrin, Ill. (No. 185).  
Apishapa, Colo. (No. 186).  
Raritan, N. J.  
Phillipsburg, Mont.  
Ellijay, Ga.-N. C.-Tenn.  
Barnesboro-Patton, Pa.  
Tallula-Springfield, Ill.  
San Francisco, Cal.

Colorado Springs, Colo.  
Eureka Springs-Harrison, Ark.  
Silver City, N. Mex.  
Columbus, Ohio.  
Eastport, Me.  
Castle Rock, Colo.  
Berea-Cleveland, Ohio.  
Niagara, N. Y.  
Minneapolis-St. Paul, Minn.



Three persons are employed in this subsection. A fourth man was employed during the early part of the year.

TOPOGRAPHIC MAPS.

At the beginning of the year 151 atlas sheets and special maps were on hand for publication. The accessions during the year were 119. The separate map publications during the year numbered 114, of which 90 were new engraved sheets, 14 revised sheets (of which 5 were reengraved), and 10 photolithographs. Sixty-five maps were in process of publication and 102 new maps were on hand awaiting action at the end of the year. The following statement shows the status of map editing June 30, 1912:

*Status of work on engraved maps June 30, 1911, and June 30, 1912.*

	1912	1911
Published during the year.....	114	86
In process of engraving.....	65	56
Not taken up.....	102	96

The manuscripts edited during the year comprise 103 topographic atlas sheets and other maps prepared for engraving; 10 State maps on scale of 1:500,000 and two large-scale contour maps, prepared for photolithography; corrections for 148 maps hitherto published; 13 maps published under contract; and 240 maps for illustration of 34 Geological Survey reports. The proof read comprises 96 new topographic maps, corrections to 83 old ones, and 23 maps published under contract. All but two of the 21 index circulars of the series 9-323 were revised and reprinted during the year, and an index map showing progress of topographic surveys in the State of Kentucky was prepared and printed for the State geologist.

Five men were employed in the work of this subsection during the whole year and two others during the second half of the year.

SECTION OF DISTRIBUTION.

The section of distribution received during the year 175 new books, 36 reprinted books, 6 folios, 42 geologic maps, 90 new topographic maps, 14 revised maps, 10 photolithographs, and 166 reprints of maps, a total of 539 publications. The total of all editions received was 437,501 books, 30,127 geologic folios, and 982,412 maps, a grand total of 1,450,040.

Reprints of the following publications were delivered to the Survey during the fiscal year 1912: Bulletins 452, 467, 470-B, 479, 480, 530-A, 530-B, 511; Water-Supply Papers 170, 172, 173, 174, 200, 201, 202, 203, 204, 206, 207, 208, 209, 210, 211, 213, 214, 219, 231, 232, 247, 248, 249, 255, 257, and 273; one advance chapter from Mineral Resources for 1911, namely, "The production of antimony, arsenic, bismuth, and selenium in 1911;" and Professional Paper 73.



There were distributed 437,637 books, 30,743 folios, 658,240 maps (including 529,656 sold), a total of 1,126,620.

The total amount received and turned into the Treasury as the result of sales of publications was \$25,755.22, of which \$21,356.27 was the proceeds of sales of topographic and geologic maps, an increase of \$4,171.67 over the amount received in the fiscal year 1911.

Fifteen persons were employed in this section during the year.

#### DIVISION OF ENGRAVING AND PRINTING.

##### MAPS, FOLIOS, AND ILLUSTRATIONS.

During the fiscal year 114 topographic atlas sheets, with a total printing of 917,572 copies, and 2 special maps were published, and at the end of the year 65 sheets were in various stages of progress toward publication. The number of sheets published is 25 in excess of the number published in 1911.

Corrections were engraved on the plates of 163 maps hitherto published. Editions of 268 maps, including new sheets and reprints, were printed and delivered to the map room, an increase of 37 over the figure for 1911.

Six geologic folios were published, three of them in two forms, and 30,127 copies of eight different folios were printed and delivered, an increase of 9,237 copies over the figures for 1911. Eleven geologic folios were in various stages of progress toward publication.

Under contracts with the Government Printing Office awarded on competitive bids, illustrations were printed for the following Survey publications: Bulletins 448, 452, 467, 470-B, 471-B, 471-E, 478, 483, 485, 498, 500; Professional Papers 71, 73, 74, 75, 78; Water-Supply Papers 231, 277, 279; Mineral Resources—Production of coal in 1910, Production of cement in 1911, Production of salt and bromine in 1910.

For the Government Printing Office also the following items were printed and delivered: Illustrations for the Annual Report of the Governor of Arizona; Annual Report of the Governor of Alaska; Annual Report of the Superintendent of Crater Lake National Park; Annual Report of the Chief of Engineers, United States Army; Annual Report of the Chief Signal Officer, United States Army; Annual Report of the War Department, vol. 1; Annual Report of the Superintendent of Glacier National Park; Annual Report of the Governor of Hawaii; Annual Report of the Governor of New Mexico; Annual Report of the Superintendent of Sequoia and General Grant National Parks; Annual Report of the Superintendent of Yosemite National Park; Annual Report of the Commissioner of Indian Affairs; Annual Report of the Superintendent of the Coast and Geodetic Survey; Report of the Commissioner of Corporations on the Lumber Industry, Part I; Report of the Commissioner of Corporations on Transportation by Water in the United States, Part III

(Water Terminals); Report of the Commissioner of Corporations on Water-Power Conditions in the United States, Parts I and II; Report on the Platt and Wind Cave National Parks, Sullys Hill Park National Monuments, and Bird Reservations; Twenty-third Statistical Report on Railways in 1910; twenty Senate and House Documents; Special Publications Nos. 9 and 10 of the Coast Survey; Bulletin 36 of the Bureau of Mines; Bulletin 101 of the Bureau of Ethnology; Bulletin 222 of the Office of Experiment Stations; Bulletin of the Bureau of Fisheries, vol. 31 (1911); Catalogue of Charts and Plans, United States Atlantic Station; Population Bulletin of the United States. In addition to the above, the following separate illustrations were printed and delivered to the Government Printing Office: Ringlemann's Scale for Grading Density of Smoke; Stadia Diagram No. 1; Stadia Diagram No. 2; Diagram of Zone Tariff for Proposed Parcels Post; Hearings No. 30, White Earth Reservation; Survey of Oyster Bars in St. Marys County, Maryland; The Omaha Indians vs. the United States; Map of North America; Map of Peat Deposits; and Mineral Plat.

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 63 national forests, 39 proclamation diagrams of national forests, map of North America (western half), map showing production of lumber by States and kinds, map of South America showing natural forest regions, index map of national forests, statistical diagram, stadia rod patterns, scales, and diagram of lookout station protractor; for the General Land Office, 1,189 township plats, 681 mineral plats, maps of Cœur d'Alene and Rosebud Indian reservations, and other miscellaneous work; for the Department of the Interior, maps of three national parks, two national monuments, seven bird reservations, and Hot Springs Reservation; for the Reclamation Service, a large amount of miscellaneous work; for the Office of Indian Affairs, 11 township plats and maps of 9 Indian reservations. Work was also done for the Interstate Commerce Commission, Civil Service Commission, War Department, United States Military Academy, Bureau of Mines, Bureau of Standards, Department of Agriculture, Weather Bureau, Smithsonian Institution, Department of Justice, Bureau of Insular Affairs, United States and Canada Boundary Survey, Biological Survey, House of Representatives, Army Service Schools, Army War College, Alaska Boundary Survey, and Post Office Department. This work for other branches of the Government amounted to about \$40,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Of contract and miscellaneous printing of all kinds, the total number of copies delivered was 2,150,859, which required 5,695,629

printings. The total number of copies printed, including topographic maps and geologic folios, was 3,129,308, requiring 10,744,192 impressions. On requisition of the Government Printing Office, 383 transfer impressions were made and shipped to contracting printers.

#### **INSTRUMENT SHOP.**

The work of the instrument shop consisted of repairing surveying, drafting, engraving, stream-gaging, and other instruments and making copper plates and electrotypes. More than 2,000 repairs and overhauls were made, 104,421 square inches of new copper plates were made and 4,641 square inches were resurfaced, and 10,712 square inches of electrotypes were made.

#### **PHOTOGRAPHIC LABORATORY.**

The output of the photographic laboratory included 14,972 negatives, of which 11,356 were dry, 3,078 were wet, and 538 were paper, and 39,128 prints, of which 13,020 were maps and diagrams and 26,108 were photographs for illustrations.

#### **ADMINISTRATIVE BRANCH.**

##### **EXECUTIVE DIVISION.**

The work in the executive division was of the same scope as in other years, except for the transfer to it of the carpenter shop and the transfer from it to the section of distribution of the handling of local map sales—that is, sales to those who call in person to purchase maps.

*Mails, files, and records.*—During the year 411,847 pieces of incoming mail were handled in this division, of which 269,988 were distributed unopened to the various branches, divisions, and sections of the Survey and to individuals and 141,859 were opened and referred. The latter figure represents an increase of 5.56 per cent over that for the fiscal year 1911. No comparison can be made of the amount of mail distributed unopened during the years 1911 and 1912, as the record for last year covers only four months. Of the mail received, 2,664 pieces were registered, which is an increase over the preceding year of nearly 3 per cent.

Of the letters opened in this division 28,199 contained remittances for Survey publications, amounting to \$26,909.31.

Practically the entire services of four clerks and about half the time of a fifth were required in recording, referring, and filing correspondence.

In December, 1911, a new method of handling outgoing mail for the entire Survey was adopted. Previous to that time boxes were located in various parts of the building, in which mail of all classes was deposited. This mail was collected and bagged by the wagon

driver. Under the new method these boxes have been discontinued, all mail, except large sendings of publications, being deposited in appropriate drops in a central mail room and there counted and bagged. This prevents mistakes in placing mail of different classes in the same bag and permits a record of the number of outgoing pieces of various classes. As this new plan has been in operation only a little over six months, it is impossible to give figures for the year.

As formerly, letters prepared in the various branches, divisions, and sections for the signature of the Secretary, the Director, and the chief clerk have been inclosed in envelopes and mailed by the executive division. The number of such letters mailed during the year was 83,184, an increase of nearly 17 per cent over last year. The number of pieces of outgoing registered mail was 18,097, a decrease of about 13 per cent.

With a view to devising and installing an improved system for the general files, the Survey employed, in December, 1911, an additional file clerk, who, during the last half of the fiscal year, was engaged in familiarizing himself with the method of filing already in use, examining filing systems in a number of other Government bureaus, and preparing, after a decision had been reached to adopt it, a subject classification in accordance with the Dewey system. This classification was completed at the close of the fiscal year in time to put it into operation on July 1, 1912.

A plan providing for a personnel file, to consist of separate folders for each member of the Survey holding a Secretary's appointment, containing correspondence and other papers relating to his appointment status and personnel record, was put into effect during the last half of the year. This file has been exceedingly useful.

*Personnel.*—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 880 persons, compared with 862 at the close of the fiscal year 1911. The total number of changes in the personnel for the year was 765, which included original appointments, separations, promotions, extensions, and changes of status of every description. Of these, 177 were new appointments, 159 were separations, 383 were promotions, and 2 were reductions.

During the year 14,069 days of annual leave and 2,921 days of sick leave were granted, being about 67 per cent of the amount of annual leave and 14 per cent of the amount of sick leave which it is permissible to grant under the law; also 4,423 days of leave without pay. In addition to the above, the transfers to State pay rolls in cooperative work amounted to 3,392 days of service.

*Property.*—An inventory of nonexpendable property in Washington was submitted to the department at the close of the calendar year 1911.

*Express and freight.*—During the year 4,013 pieces of freight and express were handled, of which 1,155 were outgoing and 2,858 were incoming. There were 541 transportation accounts checked, an increase of about 20 per cent.

*Purchase of supplies.*—The purchase of supplies, which includes the work of procuring bids, issuing orders, and preparing vouchers covering all purchases made directly by the Survey in Washington, required the services of two persons. The number of requisitions handled was 2,010, a decrease of about 7 per cent. The number of orders drawn, however, was 1,775, a decrease of but 1 per cent.

*Stationery, printing, and miscellaneous supplies.*—There were 7,355 requisitions filled from stock in the stationery room. The requisitions drawn on the department numbered 319 for miscellaneous supplies, 167 for stationery, and 439 for printing. These figures show an increase of nearly 3 per cent over 1911 in the number of requisitions filled from stock. The decrease in the number of requisitions for stationery and for miscellaneous supplies drawn on the department, slightly over 9 and 3 per cent, respectively, is due to the fact that larger quantities are ordered at one time. In the number of requisitions for printing there was an increase over the previous year of about 2 per cent.

DIVISION OF DISBURSEMENTS AND ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below:

*Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1912.*

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of the Director .....	\$35,340	.....	\$35,340.00	\$35,271.98	\$68.02
Salaries, scientific assistants.....	29,900	.....	29,900.00	29,899.92	.08
Skilled laborers, etc.....	20,000	.....	20,000.00	19,999.85	.15
Topographic surveys.....	350,000	\$3,134.29	353,134.29	350,050.46	3,083.83
Geologic surveys.....	300,000	56,493.63	356,493.63	349,846.47	6,647.16
Mineral resources of Alaska.....	100,000	19.50	100,019.50	96,718.13	3,301.37
Chemical and physical researches.....	40,000	335.35	40,335.35	37,572.23	2,763.12
Preparation of illustrations.....	18,280	.....	18,280.00	18,217.66	62.34
Mineral resources of the United States..	75,000	13.36	75,013.36	74,133.06	880.30
Gaging streams, etc.....	150,000	20,986.34	170,986.34	166,465.71	4,520.63
Books for the library.....	2,000	.....	2,000.00	1,025.76	974.24
Geologic maps of the United States.....	110,000	71,884.34	181,884.34	150,525.61	31,358.73
Surveying national forests.....	75,000	2,838.90	77,838.90	77,121.72	717.18
	1,305,520	155,705.71	1,461,225.71	1,406,848.56	54,377.15

The following table gives the classified net expenditures by the Survey for the fiscal year, the repayments shown in the preceding table having been deducted:

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1912.

ADMINISTRATIVE BRANCH.

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Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persons.	Subsistence and care of animals, etc.	Communication service.	Printing, engraving, lithographing, etc.	Furnishing heat, light, power, etc.	Special and miscellaneous services.	Materials.	Stationery draft- ing, etc., supplies.
Salaries, office of the Director	\$35,271.98	\$35,271.98										
Salaries, scientific assistants	29,899.92	29,899.92										
Skilled laborers, etc.	19,999.85	19,999.85										
Topographic surveys	346,916.17	229,399.56	\$27,357.68	\$5,797.35	\$32,708.04	\$10,613.95	\$568.85	\$5,780.45		\$5,268.19	\$1,190.59	\$941.96
Geologic surveys	293,352.84	224,985.08	19,796.16	1,992.44	14,312.63	4,442.92	416.33	5,285.20	\$103.70	2,787.58	284.43	1,471.09
Mineral resources of Alaska	96,698.63	58,542.18	12,779.35	5,498.85	5,031.69	871.65	148.75	1,024.28		776.42	227.07	175.87
Chemical and physical researches	37,236.88	22,167.11	1,398.58	1,672.90	698.60	183.67	47.26	125.37	268.59	462.42	444.25	859.31
Preparation of illustrations	18,217.66	16,188.75		17.10			13.63	1,700.75			2.58	71.75
Mineral resources of the United States	74,119.70	62,271.19	3,260.64	333.16	2,341.13	7.65	908.48	182.23	1.75	439.84	15.05	469.25
Gaging streams, etc.	145,479.37	109,910.13	12,517.91	951.61	6,819.84	342.02	603.01	2,227.06		852.61	651.62	893.28
Books for the library	1,025.76			7.90			74					
Geologic maps of the United States	78,641.27	61,134.06	68.45	79.46	68.95		52.71	2,403.35	1,108.26	561.97	1,529.63	9,086.73
Surveying national forests	74,282.82	45,881.15	2,618.23	1,899.35	3,159.58	5,852.93	39.98	305.18		272.34	317.43	104.02
	1,251,142.85	915,650.96	79,797.00	18,250.12	65,140.46	22,314.79	2,799.74	19,033.87	1,482.30	11,421.37	4,642.65	14,073.26
Appropriation.	Fuel.	Mechanic's, engineer's, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forge and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Rent of buildings.	Fees for licenses, permits, etc.
Salaries, office of the Director												
Salaries, scientific assistants												
Skilled laborers, etc.												
Topographic surveys	\$315.43	\$50.44	\$45.50	\$61.40	\$5,758.58	\$9,706.03		\$306.18	\$6,742.15	\$4,245.24	\$32.85	\$26.75
Geologic surveys	147.88	96.95	74.93	60.65	2,377.40	5,621.52	\$33.35	206.63	8,824.00		47.25	4.72
Mineral resources of Alaska	68.62	23.12	67.72	360.28	1,203.59	2,775.94	70.73	83.59	6,950.93		18.00	
Chemical and physical researches	418.62	85.42	6.77	9.00	119.59	608.28	6.65	116.98	7,485.18		51.33	1.00
Preparation of illustrations									223.10			
Mineral resources of the United States	.90		10.80					6.17	3,037.96		833.00	.50
Gaging streams, etc.	21.20	130.52	28.45	201.80	174.36	325.13	2.95	54.99	6,014.07		2,755.31	1.50
Books for the library									1,017.12			
Geologic maps of the United States	83.16	442.54	27.56	17.64					1,976.80			
Surveying national forests	86.88	5.26	75.62	3.00	1,479.58	5,838.59	11.30	35.67	4,885.29	1,335.96	75.50	
	1,142.00	834.24	337.36	713.77	11,113.10	24,874.49	124.98	810.21	47,156.60	5,581.19	3,813.24	34.47



## LIBRARY.

During the year the library has received by purchase and exchange 12,886 books and pamphlets and 1,124 maps, some of which are of temporary value only and will not be recorded as accessions to the permanent collection. A careful estimate shows that the library now contains 87,000 books, 100,000 pamphlets, and about 100,000 maps. Accessions are restricted as closely as possible to publications that consider subjects within the scope of the Survey's work and that will probably be of permanent value. Publications on other scientific subjects are transferred to the Library of Congress. Notwithstanding the efforts to confine the increase to the narrowest limits consistent with usefulness, the need of additional shelf room is now urgent.

The number of persons consulting the library during the year was 11,077, and 11,126 books and 317 maps were loaned for use outside.

The cataloguing of current accessions by full title entries in the author and subject catalogues was kept up to date. During the year 3,481 volumes and maps were catalogued.

Additions to the card catalogue during the year numbered 7,522. The Survey continues to furnish to the Library of Congress, for printing on its cards, the catalogue entries of geologic publications; of these entries 542 were supplied during the year.

The correspondence consisted of 4,587 letters received and 3,132 letters written and, as in other years, related largely to the exchange of publications. The list of institutions to which full sets of Survey publications are distributed now numbers 311 in the United States and 564 in foreign countries, a total of 875. Publications that are of value to the library are received in exchange from most of the institutions on this list. To an additional list of 523 persons and institutions, domestic and foreign, selected publications are furnished in return for certain of their own publications supplied to the library. The geologic folios are furnished to 380 libraries, in addition to the depository libraries supplied by the superintendent of documents, Government Printing Office.

The bibliography of North American geology for 1910 was completed and issued as Bulletin 495. It contained 1,410 author entries, an increase of 105 over the volume for 1909. The bibliography for 1911, containing 1,266 author entries, will be ready for the printer in July and will be published as Bulletin 524.

The personnel of the library consisted of the librarian, the assistant librarian, two cataloguers, and three other persons.



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DEPARTMENT OF THE INTERIOR  
UNITED STATES GEOLOGICAL SURVEY  
GEORGE OTIS SMITH, DIRECTOR

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THIRTY-FOURTH ANNUAL REPORT

OF THE

DIRECTOR OF THE UNITED STATES  
GEOLOGICAL SURVEY

TO THE

SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR  
ENDED JUNE 30

1913

WASHINGTON  
GOVERNMENT PRINTING OFFICE  
1913



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# THIRTY-FOURTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

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GEORGE OTIS SMITH, *Director.*

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The appropriations for the work of the United States Geological Survey for the fiscal year 1912-13 comprised items amounting to \$1,497,920. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

## SPECIAL FEATURES.

### SCOPE OF WORK.

The detailed statement which forms the greater part of this administrative report indicates the nature and extent of the public work performed by the Geological Survey. While in response to public opinion as expressed by Congress, both at the time of the Survey's creation and in recent years, and to the necessities of public-land administration, the greater emphasis has been properly placed upon the work relating to the public domain, yet the activities of this bureau cover the whole country. In the matter of geologic investigation field work was done last year in 45 States and in Alaska, while general studies were continued that have no definite geographic limitations. Topographic mapping was continued in 26 States, the District of Columbia, Alaska, and Hawaii, and the investigation of water resources included the gaging of streams in 42 States, Alaska, and Hawaii, work on underground waters in 19 States, and engineering studies of water utilization on the public lands. Add to this the statistical inquiries covering every mineral product and addressed to about 62,000 producers, with the accompanying study of the nature and extent of the mineral resources upon which the mineral industry depends, and it will be seen that the Geological Survey is in close touch with the physical development of the whole country.

Another measure of the activities of the Geological Survey as a field service may be afforded by the statement that during the year 378 field men of the regular staff, geologists and topographic and

hydraulic engineers, were engaged in field examinations and investigation for longer or shorter periods. This figure does not include an even larger number of temporary assistants.

It follows that the Geological Survey is essentially a field service, and its policy and procedure in the public work intrusted to it are based on recognition and appreciation of field conditions. Practically every officer having large administrative responsibilities connected with its field operations has been connected with the service for at least a score of years and has worked in every grade of field position. This constitutes perhaps the largest factor in the determination of the policy and standards controlling the work of the Geological Survey.

#### GROWTH OF WORK.

During the last six years the field investigations of the Survey and the office work connected therewith have shown remarkable growth. Notwithstanding the fact that within that period the former technologic branch of the Survey has become an independent organization, the Bureau of Mines, the older bureau is larger now than it was six years ago.

In personnel the net growth since 1907 has been about 37 per cent; in general correspondence the number of incoming letters now exceeds that of 1907 by 43 per cent; the total distribution of reports and maps has increased 23 per cent, the increase in maps sold being even larger, 25 per cent; and the total cash receipts from sales of publications are larger by 60 per cent than in 1907. In the matter of total printed pages in the published reports there has also been a notable increase, though it is impossible to state this exactly by reason of changes in measure of page and size of type.

During this period, however, notwithstanding these gains in every particular that can be stated statistically, there has been a net loss in annual appropriations. The \$350,000 appropriated in items under the technologic branch in 1907 has been only in part replaced by increased amounts now appropriated in other items, although the net loss is also in part offset by increased cooperation by the States in the field work of this Federal service. Thus the fact becomes apparent that in spite of a large measure of growth in public demands, as proved by the increase in correspondence and in distribution of publications, especially in publications sold, there has been no increase in the total appropriations available for sustaining the work of this bureau.

If the most recently organized branch of the Survey, the land-classification board, is taken, even more noteworthy items of growth can be cited for a single year. With the board's work largely increased in every line of activity, the formal land-classification reports

prepared for a single bureau, the Office of Indian Affairs, show for 1912-13 an increase in number of 20 per cent over the previous year. The letters received in the land-classification board increased 32 per cent, and the outgoing letters 70 per cent. It is not surprising that the files of this branch doubled in volume this last year.

The fact that more public work is being performed without corresponding increase in expenditure is unmistakable evidence of efficiency and economy. Efficiency in the public service is the end sought by an increasing number of administrative officers throughout the departmental service. The constant and painstaking effort of responsible chiefs and clerks in all grades is to make the largest returns to the public for the money appropriated by Congress. The motive of public service is often as effective in these kinds of Government work as the incentive of personal gain in private enterprise.

Because of this increasing pressure of official work, overtime service has become almost habitual in many of the divisions of the Survey. Of the scientific members of the organization, several will be found working at their desks every evening during the winter, often until midnight, so that many of the geologists and others average at least 10 per cent overtime. In the clerical force, where there is the same devotion to duty but possibly not the same personal interest in the work, the record is no less creditable in the amount of voluntary and, indeed, volunteered service. In one group of clerks, for instance, the overtime throughout the year averages about 5 per cent; in another group the average is 7 per cent, the extra time reaching 9 per cent in one of the winter months. In another section an extra hour a day is required of the whole force during periods of a week or more when the demands from the public are especially heavy, the time of service showing, for instance, an increase of 20 per cent in a single month. The library is regularly kept open an extra hour during the winter to facilitate its use in connection with the official scientific work.

Another gratifying evidence of devotion to work is furnished in the records of attendance. Usually an average of only two-thirds or less of the total annual leave permissible under the law is taken by Survey members, while 10 to 14 per cent is the average sick-leave record ( $12\frac{1}{2}$  per cent this last year). In the field work of the Geological Survey the men know no official hours; they regulate the length of the working day only by the season, and even after darkness has fallen there may be several hours of accounting and clerical work in the tent before the chief of party or his principal assistants turn in for the night.

In connection, however, with this matter of overtime work and what may be considered a maximum output, it is believed that the limit has been reached and that a crisis now faces the work in charge

of this bureau. The activities imposed by Congress upon the Geological Survey have been increasing faster than the appropriations provided therefor, until now it is all too apparent that the organization is undermanned and underequipped. Overtime work under adverse conditions is, as already stated, evidence of enthusiastic loyalty to the public service, but the strain is cumulative and the organization is bound soon to weaken, while both the quality and the quantity of the product must plainly suffer unless more adequate appropriations are voted by Congress. The demand upon the Survey for more work can not be checked, but the means to meet the demand can be provided.

#### **LIMITATIONS UPON EFFICIENCY AND ECONOMY.**

In the Geological Survey, as in other bureaus of the Government, the endeavor to administer public funds economically is distinctly hampered by statutory and other limitations. In the thirty-third annual report detailed mention was made of the loss of efficiency, as well as danger to life and property, resulting from the crowding of a large office force and a great accumulation of technical records in utterly inadequate quarters. Since that report was published Congress has authorized the erection of an office building of modern type to accommodate the Geological Survey, Office of Indian Affairs, Reclamation Service, Bureau of Mines, and other offices of the Department of the Interior, with a cost limit, exclusive of site, of \$2,596,000. On June 13, 1913, the Secretary of the Treasury included in the current deficiency estimates an item of \$25,000 to provide for technical and engineering services in the Office of the Supervising Architect in preparing plans for the building and for beginning its construction. It is to be noted that the same estimates include an item of \$99,261.83 to replace property and equipment destroyed by the fire of May 18, 1913, in the basement of the building now occupied by the Survey.

Another efficiency limitation of quite a different type from that imposed by inadequate and dangerous quarters is presented in the restrictions placed in one way or another upon the selection of personnel. Under "lump-sum" appropriations there is a fair opportunity to obtain high-grade service in the scientific and technical positions, yet even here the restraining influence of precedent prevents attaching to the higher positions salaries that are more than a fraction of those which the well-trained specialists best fitted for those positions can obtain for similar work in the service of corporations. This condition has resulted in many of the members of the Geological Survey leaving Government service at the time when they have become most valuable as public servants. Thus in the four and one-half years ending January, 1913, 41 geologists left the Government service

for the primary purpose of bettering their financial condition, and these men are known to have received salaries outside of the public service amounting to an average immediate advance of 149 per cent, or practically two and one-half times the salaries paid them by the Geological Survey.

The only optimistic view to take of this condition, whereby some of the better men are constantly resigning in every branch of the bureau, is to count this loss to the Survey as one measure of the educational contribution that the public service is making to the world's work.

In the clerical parts of the Survey organization a restriction whose effect is fully realized only by those who seek efficiency is the apportionment feature of the civil-service law. It is well known that the lists of clerks and stenographers who have passed the civil-service examinations with high rank but who are, simply because of their residence in States whose quotas are exhausted, ineligible for other than temporary appointment contain as a rule far more efficient candidates, as shown by their high ratings, than those who are eligible so far as residence is concerned. The policy of barring the best clerks from the classified service simply because of residence in this or that State seems to the administrative officer only one step removed from exclusion from Government employment on purely partisan grounds, and from his point of view is no more favorable to the attainment of the best results. Too much of the effort in "civil-service reform" has been devoted to the protection of the worker rather than of the work, and too often the needs of the public service to have its work well done have been overlooked in the effort to insure equality of opportunity to all applicants for employment.

A serious limitation upon economy in the administration of the Survey appropriations results from the discordance between the fiscal year and the field season. The necessity of making field plans and starting field projects on July 1, when the natural season for field work is well advanced, involves not only great inconvenience but serious loss. Congress has in some measure relieved this unnatural situation by making certain of the appropriations for the field service wholly or in part immediately available. Yet even this plan fails to afford practical relief when, as last year, the appropriation act was not finally passed until late in the summer (August 24). It is difficult to estimate closely the loss involved, but it can be safely stated that, as a result of this delay, probably never before has the unit cost of field work in the operations of the Geological Survey been so high as this last year.

The division of the field service most severely affected was, of course, that operating in Alaska. Congress for a number of years has recognized the necessity of making the plans for Alaskan investiga-

tions far in advance of the opening of the field season by including the annual grant of funds in the first appropriation bill passed. Thus, the money has usually become available between the first of January and the middle of February, making it possible to formulate plans and to move supplies during the winter. By this policy the plans could be carried out economically and efficiently. It will be evident that the dispatching of a large number of parties to inaccessible regions of Alaska is not practicable until it is definitely known what funds will be available. As a consequence of the delay in the appropriation for 1912-13 but little could be accomplished, and the projects undertaken could be carried out only at relatively heavy expense. Only three parties out of the twelve eventually dispatched to Alaska had a full season for field work, these being supported up to the end of June from the balance left from funds of the previous year and from then to the time the regular appropriation became available by the temporary grants made by Congress. As funds permitted several other parties were dispatched on the basis of these temporary grants, which were, however, so inadequate that the parties were undermanned and but poorly equipped.

Among the important pieces of work which had to be abandoned were an exploration through the western part of the Colville basin to Point Barrow and geologic and topographic reconnaissance surveys in the Talkeetna and Broad Pass regions. In the preparation for the latter undertaking provisions had been dispatched to Valdez Creek, some 300 miles from the coast, at a very heavy expense. A reconnaissance of the Yakataga region and detailed geologic and topographic surveys of the eastern part of the Matanuska coal fields and of the Willow Creek gold district were also planned but could not be carried out.

#### **ALASKA RAILROAD COMMISSION.**

A special contribution was made by the Survey to the work of the Alaska Railroad Commission, which was created by the Sixty-second Congress and charged with the investigation of transportation routes in Alaska. The commission consisted of five members, and the Survey geologist in charge of the investigation of mineral resources in Alaska was named in the statute as one of these members. Alfred H. Brooks was therefore designated by President Taft to serve as a member of the commission and as vice chairman. Mr. Brooks visited Alaska with the other members of the commission, leaving Washington September 3 and returning December 1, 1912. The resulting report was submitted to the President and by him transmitted to Congress January 20, 1913.



**REPORT ON LAND CLASSIFICATION.**

A feature of special interest in connection with the year's work was the preparation for publication of Bulletin 537, "The classification of the public lands." This bulletin contains contributions by many authors, including the Director of the Survey, practically all the technical force of the land-classification board, and many of the geologists and engineers of the other branches who are engaged in the field work of classification. The object of this publication was to set forth in compact and usable form the history and origin of the Survey's classification work, the basis of that work in law and in the administration of law, and briefly the processes involved both in the original field investigations and in the office study and disposition of field results. The work has grown from small beginnings to a complete organization and a complete system of procedure. It touches upon public-land problems at many points, so that it seemed desirable, both from the point of view of members of the Survey and from that of the public, to set forth, as compactly and clearly as possible, the general features of the organization and the general principles which govern the work. The preparation of the bulletin involved the diversion of a considerable portion of the energies of the land-classification board staff for a part of one or two months of the fiscal year.

**FIRE IN THE SURVEY BUILDING.**

A fire occurred in the basement of the Survey building on Sunday, May 18, the cause of which is unknown, but which may have resulted from the short-circuiting of electrical wires. The destruction of the entire building was at one time seriously threatened, but the fire was fortunately confined to the basement and therefore resulted in the loss of only replaceable property. The fire destroyed about 175,000 copies of the latest topographic maps, destroyed or seriously damaged the entire stock of geologic folios, aggregating about 200,000 copies, and partly or wholly destroyed about 60,000 book publications, most of which were reserve copies, including the older and rarer publications. Among these was the "library reserve," comprising from four to six copies of each publication heretofore issued by the Survey, constituting the only complete sets of Geological Survey publications known to be in existence, except those in libraries. The fire damage is estimated at approximately \$100,000 for property which should be replaced, but this estimate does not include a considerable additional damage to material and publications—not sufficient, however, to condemn them as useless.



**WORK OF THE YEAR.****DECREASE IN APPROPRIATION.**

The appropriations made directly for the Geological Survey showed a decrease of \$10,000 as compared with those for the fiscal year 1912, this amount having been temporarily cut off from the appropriation for the investigation of Alaskan mineral resources. This action was taken by Congress on account of the delay in making the appropriation and the belief by Congress that the full appropriation would not be needed. Owing to the extreme lateness in making the appropriation, and therefore providing for working funds, considerable less than the usual amount of field work was accomplished, the field season being on this account thus cut down practically one-half. However, as soon as the money became available parties were rushed to the field and the utmost endeavors were made to turn out something approaching the present standard of work. Parties were kept in the field later than usual in the fall, considerable work being done after snowfall and more than the usual amount of work was done in the early spring.

**PUBLICATIONS.**

The work of the Geological Survey is reflected chiefly in the publication and distribution of its printed reports and maps. During the fiscal year ended June 30, 1913, the number of reports printed was 253,850 copies and the number distributed was 375,213 copies of these reports and reports previously printed. The reports are sent out only on application.

Under the special stimulation of a reduced price because of damage by smoke and water, the geologic folios were sold in large numbers. From May 20, immediately after the fire, to June 30 these sales amounted to more than 27,000 copies, and it is believed that this distribution among teachers, students, business men, and others really desirous of using the publications of this series will make future issues more popular.

The publications of the year are listed below.

**THIRTY-THIRD ANNUAL REPORT** of the Director of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1912. 175 pages, 2 plates.

A report on special features of the Survey's work, brief abstracts of publications of the year, and a summary of work by branches and divisions, with maps showing the progress of topographic and geologic surveys.

**MONOGRAPH LI.** Cambrian Brachiopoda, by C. D. Walcott. (In two parts.) 1912. Part I, 872 pages, 76 text figures; Part II, 104 plates. Price \$4.

A work setting forth the results of a systematic study of the Cambrian brachiopod fauna of the world and its relation to Ordovician and later fauna. This work contains descriptions of 477 species and 59 varieties of Cambrian brachiopods and 42 species and 1 variety of Ordovician brachiopods. *Figures of 538 forms are given.*

The Cambrian Brachiopoda are considered historically, geologically, and zoologically. The historical treatment comprises a bibliography and a table of synonymic reference, giving a completely cross-referenced list of described species with the present generic and specific reference of each; the geologic treatment covers general geographic and stratigraphic distribution, detailed geographic distribution, detailed stratigraphic distribution, habitat, and fossil localities. The zoologic treatment covers the physical characters of the Brachiopoda, their distribution, their evolution, and their classification.

**PROFESSIONAL PAPER 71.** Index to the stratigraphy of North America by Bailey Willis, accompanied by a geologic map of North America compiled by the United States Geological Survey in cooperation with the Geological Survey of Canada and the Instituto Geológico de México under the supervision of Bailey Willis and G. W. Stose. 1912. 894 pages, 1 plate, 19 text figures.

This paper is a compilation designed to explain the geologic map which accompanies it. The map is printed in four parts, which together make a wall map 60 by 77 inches, and is excellently adapted to use in classes. It is also sufficiently detailed to be serviceable for close study, for although it shows 42 divisions of rocks that can be studied at close range, the color scheme is so planned that when it is used as a wall map at a distance the minor distinctions merge and the major divisions stand out prominently. The map is therefore indispensable to both teacher and student.

The compiler of this volume has assembled the latest or most authoritative statements of fact and opinion, selected according to his best judgment. The material selected comprises discussions of stratigraphy, citations of significant fossils, and views on correlation. The aim has been to state stratigraphic facts as fully as the data available or the scope of the work permit and to include as much as space allows relating to faunas and correlation. Quotation has been preferred, but where it was not practicable an abstract of facts has been made and the reference given. The last chapter is a bibliography of the publications cited in the text of the work. Each of the 19 text figures is a sketch map of North America showing the distribution of the rocks of a certain geologic period represented on the map and the key to references in the text.

**PROFESSIONAL PAPER 74.** Geology and ore deposits of the Butte district, Montana, by W. H. Weed. 1912. 262 pages, 41 plates, 109 text figures.

A study of the geology of this important ore-bearing district, which is the greatest mining center in the United States and the second greatest in the world. The book describes in detail the different valuable metals produced—gold, silver, copper, and zinc—their mode of occurrence, and the geologic conditions which led to their formation. A discussion of mining conditions indicates that the output of the district will remain constant for some years to come. The illustrations consist of colored geologic maps, halftone plates, and zinc etchings showing plans and cross sections of the mines and veins.

**PROFESSIONAL PAPER 77.** Geology and ore deposits of the Park City district, Utah, by J. M. Boutwell, with contributions by L. H. Woolsey. 1912. 231 pages, 44 plates, 18 text figures.

A detailed report on the areal and economic geology of the district surrounding Park City, Utah, with sections on the history and development of its mining industry, mineralogy of its ores, and descriptions of its mines.

The Park City district has won high standing as a "bonanza camp" by yielding large amounts of rich lead-silver ore, and its extensive mines rank well among the dividend-paying argentiferous lead mines of the world. Topographic and geologic maps, structure sections, and numerous halftone plates accompany the paper.

**PROFESSIONAL PAPER 78.** Geology and ore deposits of the Philipsburg quadrangle, Montana, by W. H. Emmons and F. C. Calkins. 1913. 271 pages, 17 plates. 55 text figures.

This paper treats of the geography, geology, and mineralogy of the district adjacent to Philipsburg, Mont., which contains deposits of silver and gold ore that were once richly productive. The paper includes chapters on the ore deposits, history of mining development, and treatment of the ores. The mines are described in detail and numerous illustrations, including topographic and geologic maps of the district, add to the usefulness of the book.

**PROFESSIONAL PAPER 79.** Recurrent *Tropidoleptus* zones of the Upper Devonian in New York, by H. S. Williams. 1913. 103 pages, 3 plates, 18 text figures.

A study of the paleontology of the Upper Devonian rocks of the Watkins Glen district, near Ithaca, N. Y. The importance of the investigation lies chiefly in its disclosures in regard to the ancient geography and geology of the region, as the disappearance and reappearance of the *Tropidoleptus* fauna must have been due to diastrophic changes. The illustrations consist of halftone plates of specimen fossils and sections of the rocks showing the stratigraphic position of the subdivisions of the fauna.

**BULLETIN 471.** Contributions to economic geology (short papers and preliminary reports), 1910, Part II, Mineral fuels. M. R. Campbell, geologist in charge. 1912. 663 pages, 52 plates, 15 text figures.

Includes 27 brief reports of two classes—(1) short papers giving comparatively detailed descriptions of occurrences of mineral fuels that have economic interest but are not of sufficient importance to warrant a more extended description; (2) preliminary reports on economic investigations the results of which are to be published later in more detailed form. These reports are such only as have a direct economic bearing, all topics of purely scientific interest being excluded.

A complete list of the papers included in the volume follows:

The Campton oil pool, Kentucky, by M. J. Munn.

Oil and gas development in Knox County, Ky., by M. J. Munn.

The Fayette gas field, Alabama, by M. J. Munn.

The Powder River oil field, Wyoming, by C. H. Wegemann.

Geology of the San Juan oil field, Utah, by E. G. Woodruff.

Marsh gas along Grand River near Moab, Utah, by E. G. Woodruff.

Preliminary report on the geology and possible oil resources of the south end of the San Joaquin Valley, Cal., by Robert Anderson.

Coal on Dan River, N. C., by R. W. Stone.

Lignite in the Fort Berthold Indian Reservation, N. Dak., north of Missouri river, by M. A. Pishel.

Geology of certain lignite fields in eastern Montana, by W. R. Calvert.

The Baker lignite field, Custer County, Mont., by C. F. Bowen.

The Terry lignite field, Custer County, Mont., by F. A. Herald.

The Glendive lignite field, Dawson County, Mont., by J. H. Hance.

- The Sidney lignite field, Dawson County, Mont., by Eugene Stebinger.  
The Culbertson lignite field, Valley County, Mont., by A. L. Beekly.  
The southern extension of the Milk River coal field, Chouteau County, Mont., by L. J. Pepperberg.  
The Livingston and Trail Creek coal fields, Park, Gallatin, and Sweetgrass Counties, Mont., by W. R. Calvert.  
The Electric coal field, Park County, Mont., by W. R. Calvert.  
The Little Powder River coal field, Campbell County, Wyo., by J. A. Davis.  
The Sussex coal field, Johnson, Natrona, and Converse counties, Wyo., by C. H. Wegemann.  
The Lost Spring coal field, Converse County, Wyo., by D. E. Winchester  
Coal fields of the Wind River region, Fremont and Natrona counties, Wyo., by E. G. Woodruff and D. E. Winchester.  
The coal resources of Gunnison Valley, Mesa and Delta counties, Colo., by E. G. Woodruff.  
The Tijeras coal field, Bernalillo County, N. Mex., by W. T. Lee.  
The Deep Creek district of the Vernal coal field, Uinta County, Utah, by C. T. Lupton.  
The Blacktail (Tabby) Mountain coal field, Wasatch County, Utah, by C. T. Lupton.  
Miscellaneous analyses of coal samples from various fields of the United States.

**BULLETIN 498.** Headwater regions of Gulkana and Susitna rivers, Alaska, with accounts of the Valdez Creek and Chistochina placer districts, by F. H. Moffit. 1912. 82 pages, 10 plates, 9 text figures.

Describes briefly the geology and mineral resources of an area between the upper parts of Susitna and Gulkana rivers, as the result of a reconnaissance survey in 1910. One of the chief purposes of the survey was to map and investigate the Valdez Creek placer district, which has been producing gold for a number of years. Topographic and geologic reconnaissance maps, structure sections, and halftone views of interesting geologic features make up the illustrations.

**BULLETIN 501.** The Bonnifield region, Alaska, by S. R. Capps. 1912. 63 pages, 8 plates, 3 text figures.

Describes the geography and general geology of the region lying south of Fairbanks between Tanana River and the crest of the Alaska Range. This district has long been known as a field containing some productive gold placers as well as extensive deposits of lignitic coal. Estimates which include only 122 square miles of the better-known coal fields give a coal content of 9,950,000,000 tons. The book contains topographic and geologic maps of the district described and sections of the rocks.

**BULLETIN 502.** The Eagle River region, southeastern Alaska, by Adolph Knopf. 1912. 61 pages, 5 plates, 3 text figures.

Discusses the rock formations and ore deposits of the Eagle River region, a strip of territory 32 miles long extending northwestward from Salmon Creek, near Juneau, to Berners Bay. This strip embraces nearly a third of the entire length of the Juneau gold belt and contains a large number of prospects under exploration. The illustrations include a topographic and a geologic map of the area discussed and diagrammatic sections.

**BULLETIN 503.** Iron-ore deposits of the Eagle Mountains, California, by E. C. Harder. 1912. 81 pages, 13 plates, 4 text figures.

An economic report treating of the structure, character, and quantity of the iron ores of the Eagle Mountains, in Riverside County, Cal., and their relation to the associated rocks. It includes also descriptions of these rocks and discussions of their relations to one another. The book contains a general geologic and topographic map and maps and sections showing distribution and structure of iron ore and associated rocks.

**BULLETIN 508.** The Onondaga fauna of the Allegheny region, by E. M. Kindle. 1912. 144 pages, 13 plates.

Results of research work on the fauna of the Onondaga limestone, which is recognized by geologists as a valuable reference formation in correlating other strata. The bulletin discusses the stratigraphy of the formation in the different States in the Allegheny region and the age of the fauna, and gives detailed descriptions and pictures of the fossils.

**BULLETIN 510.** Coal fields of Grand Mesa and the West Elk Mountains, Colorado, by W. T. Lee. 1912. 237 pages, 21 plates, 37 text figures.

Results of an investigation undertaken for the purpose, first, of ascertaining the geologic relations of the coal-bearing rocks to other formations; second, of classifying the land by legal subdivisions into coal land and noncoal land; and third, of determining the value of the coal land by ascertaining the thickness of the coal beds, the character and quality of the coal, its accessibility with reference to topographic features, and its location with reference to lines of transportation. The report contains a map of the Grand Mesa and West Elk Mountain field, sections of the coal beds, and halftone plates showing geologic features associated with the coal deposits and characteristic fossils by which coal of different grades may be identified.

**BULLETIN 513.** Pliocene and Pleistocene Foraminifera from southern California, by R. M. Bagg, jr. 1912. 153 pages, 28 plates, 3 text figures.

This bulletin describes in detail 128 species and varieties of fossil Foraminifera. The Pliocene specimens were obtained from highly fossiliferous sands at Timms Point, San Pedro, Cal., and the Pleistocene material from sandstone with fossiliferous lenses at Santa Barbara, Cal. The book contains halftone plates giving accurate representations of the specimens.

**BULLETIN 514.** Results of spirit leveling in New York, 1906 to 1911, inclusive. R. B. Marshall, chief geographer. 1912. 139 pages, 1 plate.

**BULLETIN 515.** Results of spirit leveling in Pennsylvania, 1899 to 1911, inclusive. R. B. Marshall, chief geographer. 1912. 164 pages, 1 plate.

**BULLETIN 516.** Results of spirit leveling in Florida, 1911. R. B. Marshall, chief geographer. 1912. 24 pages, 1 plate.

**BULLETIN 517.** Results of spirit leveling in Alabama, 1911. R. B. Marshall, chief geographer. 1912. 38 pages, 1 plate.

**BULLETIN 518.** Results of spirit leveling in Ohio, 1911. R. B. Marshall, chief geographer. 1912. 108 pages, 1 plate.

**BULLETIN 519.** Results of spirit leveling in Tennessee, 1910 and 1911. R. B. Marshall, chief geographer. 1912. 41 pages, 1 plate.

Reports on precise and primary leveling in the States indicated in their titles, showing the exact altitude above sea level of a great number of places. The work in New York, Pennsylvania, Ohio, and Alabama and that of 1910 in Tennessee was done in cooperation with the States. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

**BULLETIN 520.** Mineral resources of Alaska (report on progress of investigations in 1911), by A. H. Brooks and others. 1912. 360 pages, 15 plates.

A collection of 18 brief reports on the work of the Geological Survey in Alaska during 1911. Illustrated by maps of Alaska showing distribution of mineral resources and railway routes from the Pacific seaboard to Fairbanks, geologic sketch maps of several of the mining regions, and hydrographs showing the daily discharge of Yukon, Fortymile, and Seventymile rivers. The titles of the papers are given below:

Administrative report, by A. H. Brooks.

The mining industry in 1911, by A. H. Brooks.

Railway routes from the Pacific seaboard to Fairbanks, by A. H. Brooks.

Tin resources of Alaska, by F. L. Hess.

The Taral and Bremner River districts, by F. H. Moffit.

The Chitina copper district, by F. H. Moffit.

Gold deposits near Valdez, by A. H. Brooks.

Gold deposits of the Seward-Sunrise region, Kenai Peninsula, by B. L. Johnson.

Gold placers of the Yentna district, by S. R. Capps.

Gold placers between Woodchopper and Fourth of July creeks, upper Yukon River, by L. M. Prindle and J. B. Mertle.

Placer mining in the Fortymile and Seventymile River districts, by E. A. Porter.

Water supply of the Fortymile, Seventymile, and Eagle districts in 1911, by E. A. Porter.

Water supply of the Fairbanks, Salchaket, and Circle districts in 1911, by C. E. Ellsworth.

The Rampart and Hot Springs regions, by H. M. Eakin.

The Ruby placer district, by A. G. Maddren.

Geologic investigations along the Canada-Alaska boundary, by A. G. Maddren.

The Alatna-Noatak region, by P. S. Smith.

Notes on mining in Seward Peninsula, by P. S. Smith.

**BULLETIN 521.** The commercial marbles of western Vermont, by T. Nelson Dale. 1912. 170 pages, 17 plates, 25 text figures.

This bulletin has a twofold object—to bring the science of geology to bear upon the problems of the marble industry in western Vermont, and briefly to make known the more important scientific results obtained in the course of the mapping of the marble belts of that part of the State and in the study of its marbles. The district specially considered lies west of the Green Mountain Range in Bennington, Rutland, and Addison counties. The report describes all the quarries of commercial marble that were in operation in the State in 1910. The illustrations include geologic maps of the beds, sections of marble, and halftone plates showing ornamental uses to which Vermont marbles have been put.

**BULLETIN 522.** Portland cement materials and industry in the United States, by E. C. Eckel, with contributions by E. F. Burchard and others. 1913. 401 pages, 19 plates, 2 text figures.

This report contains a brief sketch of the general status of the Portland cement industry, a discussion of the chemical and physical properties necessary to a Portland cement material, and detailed descriptions of the available Portland cement resources of each State in the United States. Emphasis is laid on the fact that the value of cement material depends almost entirely



on its location with respect to fuel supply, transportation routes, and markets. The illustrations consist mainly of maps showing the distribution of cement materials in certain parts of the country.

**BULLETIN 523.** Nitrate deposits, by H. S. Gale. 1912. 36 pages, 2 plates, 2 text figures.

A paper describing the nitrate deposits of the world and especially of the United States, with sections on the origin of nitrate salts and the value of the United States deposits. The most important of the nitrate salts commercially are sodium nitrate (cubic niter) and potassium nitrate (niter or saltpeter), imported largely from Chile. The bulletin contains maps showing the location of nitrate claims and deposits in Nevada and Utah.

**BULLETIN 524.** Bibliography of North American geology for 1911, with subject index, by J. M. Nickles. 1912. 162 pages.

A list of papers on North American geology published in 1911, arranged alphabetically by names of authors, an index of subjects or materials, and lists showing chemical analyses reported and minerals, rocks, and formations described.

**BULLETIN 527.** Ore deposits of the Helena mining region, Montana, by Adolph Knopf. 1913. 143 pages, 7 plates, 4 text figures.

A sketch of the geology of the Helena mining region, an area of 1,300 square miles in southwestern Montana, with descriptions of mines in special districts. The dominating geologic feature of the region is the granite mass which forms the northern extension of a great intrusion known as the Boulder batholith. As a consequence of this granite invasion a series of ore deposits, chiefly gold, silver, and lead, was formed around the margin of the granite and in the roof rocks overlying it. The book contains a geologic map of the region and halftone plates showing specimens of the ores.

**BULLETIN 529.** The enrichment of sulphide ores, by W. H. Emmons. 1913. 260 pages.

A discussion of the theory of sulphide enrichment, which explains why many ore deposits, especially those of copper, are leached near the surface and are richer below the leached zone, whereas the ore at still greater depths is of lower grade. According to the theory the minerals leached from the upper zone have been carried downward and redeposited, forming an enriched zone, and the deeper, low-grade sulphide ores are assumed to have undergone no change since the original or primary mineralization of the whole deposit. This theory has proved to be of considerable economic value, having been successfully applied in the development of many deposits of the metallic sulphides.

**BULLETIN 530.** Contributions to economic geology (short papers and preliminary reports), 1911, Part I, Metals and nonmetals except fuels. Waldemar Lindgren, chief geologist. 1913. 400 pages, 7 plates, 51 text figures.

This bulletin is made up of 27 brief reports on investigations of mineral deposits except fuels in the United States in 1911. These papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. They have been grouped according to the subjects or localities treated and each group has been issued as an advance chapter as soon as it was ready. A complete list of the papers included in the volume follows:

Notes on the gold lodes of the Carrville district, Trinity County, Cal., by D. F. MacDonald.



A preliminary report on the geology and ore deposits of Creede, Colo., by W. H. Emmons and E. S. Larsen.

A preliminary account of the ore deposits of the Loon Creek district, Idaho, by J. B. Umpleby.

Geology of the St. Joe-Clearwater region, Idaho, by F. C. Calkins and E. L. Jones, jr.

Notes on the Antelope district, Nevada, by F. C. Schrader.

Notes on the northern La Sal Mountains, Grand County, Utah, by J. M. Hill.

The Turquoise copper-mining district, Arizona, by F. L. Ransome.

Notes on the vanadium deposits near Placerville, Colo., by F. L. Hess.

Vanadium in the Sierra de los Caballos, N. Mex., by F. L. Hess.

Carnotite near Green River, Utah, by F. L. Hess.

Zirconiferous sandstone near Ashland, Va., by T. L. Watson and F. L. Hess.

Alunite in the San Cristobal quadrangle, Colorado, by E. S. Larsen.

Notes on the clays of Delaware, by G. C. Matson.

Clay in the Portland region, Maine, by F. J. Katz.

Developed deposits of fuller's earth in Arkansas, by H. D. Miser.

Gypsum along the west flank of the San Rafael Swell, Utah, by C. T. Lupton.

Geology of the salt and gypsum deposits of southwestern Virginia, by G. W. Stose.

A geologic reconnaissance in southeastern Idaho, by A. R. Schultz and R. W. Richards.

Some further discoveries of rock phosphate in Montana, by J. T. Pardee.

The search for potash in the desert basin region, by H. S. Gale.

The occurrence of potash salts in the bitterns of the eastern United States, by W. C. Phalen.

Explorations of salines in Silver Peak Marsh, Nev., by R. B. Dole.

A sulphur deposit in the San Rafael Canyon, Utah, by F. L. Hess.

Sulphur deposits of Sunlight Basin, Wyo., by D. F. Hewett.

Two sulphur deposits in Mineral County, Colo., by E. S. Larsen and J. F. Hunter.

Graphite near Raton, N. Mex., by W. T. Lee.

Mica in Idaho, New Mexico, and Colorado, by D. B. Sterrett.

**BULLETIN 531.** Contributions to economic geology (short papers and preliminary reports), 1911, Part II, Mineral fuels; advance chapters as follows:

**Bulletin 531-A.** The Menifee gas field and the Ragland oil field, Kentucky. M. J. Munn. 1913. 20 pages, 4 plates.

A brief account of the history, topography, and geology of these fields, with sketch maps and suggestions to future prospectors.

**Bulletin 531-B.** Oil and gas development in north-central Oklahoma, by R. H. Wood. 1912. 31 pages, 1 plate.

The region considered in this report includes lands formerly within the Pawnee, Otoe, Ponca, Kaw, and Tonkawa Indian reservations, comprising about 82 miles from north to south and 60 miles from east to west in Grant, Kay, Osage, Pawnee, Noble, Garfield, Logan, Payne, and Lincoln counties. Localities where producing wells and test holes have been sunk were visited and an effort was made to get the exact location of all borings, the depth of each hole, the character of the product and the amount obtained, if any, and wherever possible a detailed log or record of the formations passed through by the drill.

Bulletin 531-C. Geology and petroleum resources of the De Beque oil field, Colorado, by E. G. Woodruff. 1913. 17 pages, 1 plate, 1 text figure.

A sketch of the topography and geology of this field with reference especially to its petroleum resources. The pamphlet contains a map of the field showing geologic boundaries and structure.

Bulletin 531-D. Geologic structure of the Punxsutawney, Curwensville, Houtzdale, Barnesboro, and Patton quadrangles, central Pennsylvania, by G. H. Ashley and M. R. Campbell. 1913. 23 pages, 2 plates, 1 text figure.

A discussion of the geologic structure of the area covered, designed to aid the prospector in drilling for oil or gas.

BULLETIN 532. The Koyukuk-Chandalar region, Alaska, by A. G. Maddren. 1913. 119 pages, 9 plates, 2 text figures.

This report gives a general account of the geography and geology of the drainage basins of upper Koyukuk and Chandalar rivers, but its special purpose is to describe that part of this region in which gold placers have been developed. Since 1899 the Koyukuk has produced gold to the value of \$2,500,000 and some promising gold-bearing veins have been found in the Chandalar district. The bulletin is illustrated by reconnaissance maps of the region and plates showing geologic features.

BULLETIN 534. The Yentna district, Alaska, by S. R. Capps. 1913. 75 pages, 13 plates, 7 text figures.

Describes the geography and geology of the Yentna district, an area of about 2,050 square miles in the drainage basin of Yentna River. The economic value of the district lies in its placer gold, and this paper sets forth briefly the conditions at the placer mines and the more important facts about the surface distribution of the different rock formations. Topographic and geologic maps of the district and plates showing geologic and mining conditions accompany the report.

BULLETIN 535. A geologic reconnaissance of a part of the Rampart quadrangle, Alaska, by H. M. Eakin. 1913. 38 pages, 8 plates.

This is one of a series of reports on the Yukon-Tanana region, Alaska. Although a reconnaissance report, it will be useful in outlining the general features of geology and in affording information about the mineral resources of the region, chiefly placer gold. The illustrations include reconnaissance and geologic maps of the Hot Springs and Rampart districts and maps showing distribution of placer gold.

BULLETIN 537. The classification of the public lands, by G. O. Smith and others. 1913. 197 pages, 8 text figures.

A full statement of the policy of land classification for the purpose of highest utilization and a detailed description of the procedure and methods so far found necessary to carry out that policy are presented in this bulletin. This information is of value both to students of government and to geologists and engineers interested in the application of scientific investigation to practical business. The historical and legal phases of the discussion may be of greatest interest to the citizen concerned in his country's highest development, while the description of field methods should be of immediate value in indicating new requirements imposed upon scientific education, for details of this business policy of the Government are already being adopted in private and

corporate land examinations. The text figures include diagrams and sketch maps illustrating some of the methods of land classification.

**BULLETIN 540.** Contributions to economic geology (short papers and preliminary reports), 1912, Part I, Metals and nonmetals except fuels; one advance chapter, namely:

**Bulletin 540-R.** Sulphur deposits in Park County, Wyo., by D. F. Hewett. 1913. 6 pages.

A brief account of an investigation of the sulphur deposits of Park County, Wyo., the author concluding that, because of the meagerness of the deposits, their economic importance is not great.

**WATER-SUPPLY PAPER 259.** The underground waters of southwestern Ohio, by M. L. Fuller and F. G. Clapp, with a discussion of the chemical character of the waters by R. B. Dole. 1912. 228 pages, 9 plates, 11 text figures.

The district covered by this report is an area in southwestern Ohio extending from Ohio River on the south to the southern portions of Darke and Miami counties on the north, and from the Indiana State line on the west to central Adams and Highland counties on the east. The topography, climate, and geology are described with special reference to the water-bearing formations, and the underground waters are discussed by counties. The paper contains also a chapter on the chemical character of the waters, showing the qualities required for domestic, industrial, and medicinal uses and methods of purification. The illustrations comprise a geologic map of the district, maps showing Quaternary deposits, thicknesses of water-bearing surface deposits, and artesian conditions, sections and halftone plates showing ground-water conditions in the district.

**WATER-SUPPLY PAPERS 281, 283, 284, 289, 290, 291, 292.** Parts of "Surface-water supply of the United States, 1910," prepared under the direction of M. O. Leighton:

**Part I.** Water-Supply Paper 281. North Atlantic coast, by C. C. Babb, C. C. Covert, and R. H. Bolster. 1912. 305 pages, 2 plates.

**Part III.** Water-Supply Paper 283. Ohio River basin, by A. H. Horton, M. R. Hall, and H. J. Jackson. 1912. 158 pages, 2 plates.

**Part IV.** Water-Supply Paper 284. St. Lawrence River basin, by C. C. Covert, A. H. Horton, and R. H. Bolster. 1912. 125 pages, 2 plates.

**Part IX.** Water-Supply Paper 289. Colorado River basin, by W. B. Freeman, E. C. La Rue, and H. D. Padgett. 1912. 233 pages, 4 plates.

**Part X.** Water-Supply Paper 290. The Great Basin, by E. C. La Rue, F. F. Henshaw, and E. A. Porter. 1912. 264 pages, 3 plates.

**Part XI.** Water-Supply Paper 291. Pacific coast in California, by W. B. Clapp, F. F. Henshaw, and H. D. McGlashan. 1912. 218 pages, 4 plates, 1 text figure.

**Part XII.** Water-Supply Paper 292. North Pacific coast, by F. F. Henshaw, E. C. La Rue, and G. C. Stevens. 1913. 685 pages, 3 plates.

These reports contain descriptions of the drainage basins named and the results of stream measurements in them, namely, gage-height records, results of current-meter measurements, and daily and monthly discharges. Illustrations showing typical gaging stations, current meters, and rating curves accompany each book.

**WATER-SUPPLY PAPER 293.** Underground water resources of Iowa, by W. H. Norton, W. S. Hendrixson, H. E. Simpson, O. E. Meinzer, and others. 1912. 994 pages, 18 plates, 6 text figures.

A report setting forth in detail the results of an investigation, made in cooperation by the United States Geological Survey and the Iowa Geological Survey, of the underground water resources of Iowa. The topography, geology, and water supply of each county are considered and the chemical and industrial qualities of all ground waters are discussed. The object of the investigation is to furnish to each community data showing whether artesian water can be found at that locality, at what depths water may be reached, through what formations the drill must pass, what mineral compounds—healthful or harmful—the water is likely to contain, how high it will rise, how large will be its discharge, and how such a supply will compare in cost, purity, permanence, and general availability with that from other sources. The book contains a geologic map showing the geology and artesian conditions of Iowa and geologic sections between certain cities and towns in the State.

**WATER-SUPPLY PAPER 294.** An intensive study of the water resources of a part of Owens Valley, Cal., by C. H. Lee. 1912. 135 pages, 30 plates, 8 text figures.

Presents the results of studies made by the Department of Public Works, Bureau of the Los Angeles Aqueduct, city of Los Angeles, in cooperation with the United States Geological Survey and the State of California, for the purpose of determining the available underground water supply of Owens Valley. The city of Los Angeles plans to develop a municipal water supply from the surplus surface waters reaching the lower end of the valley and from the underground sources, which have so far remained untouched. Investigations were made especially in the Independence region, an isolated portion of the valley. The data obtained are discussed under the following heads: Physical features of the region, precipitation, stream flow, evaporation and transpiration, percolation, and ground water. The book contains numerous tables showing precipitation and depth of evaporation, in inches, at certain stations, and monthly and seasonal discharges of streams tributary to the region, as well as maps and halftone plates illustrating drainage features.

**WATER-SUPPLY PAPER 296.** Gazetteer of surface waters of California, Part II, San Joaquin River basin, prepared under the direction of J. C. Hoyt by B. D. Wood. 1912. 102 pages.

**WATER-SUPPLY PAPER 297.** Gazetteer of surface waters of California, Part III, Pacific coast and great basin streams, prepared under the direction of J. C. Hoyt by B. D. Wood. 1913. 244 pages.

**WATER-SUPPLY PAPER 298.** Water resources of California, Part I, Stream measurements in Sacramento River basin, prepared under the direction of J. C. Hoyt by H. D. McGlashan and F. F. Henshaw. 1912. 411 pages, 8 plates, 3 text figures.

**WATER-SUPPLY PAPER 299.** Water resources of California, Part II, Stream measurements in San Joaquin River basin, prepared under the direction of J. C. Hoyt by H. D. McGlashan and H. J. Dean. 1912. 439 pages, 7 plates.

**WATER-SUPPLY PAPER 300.** Water resources of California, Part III, Stream measurements in the Great Basin and Pacific coast river basins, prepared under the direction of J. C. Hoyt by H. D. McGlashan and H. J. Dean. 1912. 956 pages, 4 plates.

Five of a series of six reports on the surface waters of California, prepared by the United States Geological Survey under cooperative agreement with the State Water Commission and the State Conservation Commission. Water-Supply Papers 295, 296, and 297 are gazetteers in which is listed every stream and gaging station in the river basins of California. (Water-Supply Paper 295, Gazetteer of surface waters of the Sacramento River basin, was published during the fiscal year ended June 30, 1912.) Water-Supply Papers 298, 299, and 300 describe the streams that have been measured in California and the stations at which the work has been carried on and give tables covering all the measurements and estimates made by the Geological Survey in these basins. The investigations of the flow of water in the streams have been supplemented by studies of the climatic and other factors affecting stream flow, so that these reports afford valuable data for all phases of hydraulic work.

**WATER-SUPPLY PAPERS 301, 304, 305, 310, 311.** Parts of "Surface water supply of the United States, 1911," prepared under the direction of M. O. Leighton:

Part I. Water-Supply Paper 301. North Atlantic coast, by C. C. Babb, C. C. Covert, and R. H. Bolster. 1912. 221 pages, 4 plates.

Part IV. Water-Supply Paper 304. St. Lawrence River Basin, by C. C. Covert and R. H. Bolster. 1912. 98 pages, 4 plates.

Part V. Water-Supply Paper 305. Hudson Bay and upper Mississippi River, by Robert Follansbee, A. H. Horton, and H. J. Jackson. 1913. 197 pages, 4 plates, 2 text figures.

Part X. Water-Supply Paper 310. The Great Basin, by F. F. Henshaw, H. D. McGlashan, and E. A. Porter. 1913. 210 pages, 4 plates.

Part XI. Water-Supply Paper 311. Pacific coast in California, by H. D. McGlashan and R. H. Bolster. 1912. 304 pages, 4 plates.

These reports present briefly the results of measurements of flow made on streams in the drainage basins named during the calendar year 1911. Data for each gaging station are given under the following heads: Location, Records available, Drainage area of stream, Gage, Channel, Discharge measurements, Accuracy, and Cooperation. The book also contains tables giving gage heights and daily and monthly discharges at each station, lithographed maps showing the mean annual precipitation and run-off in the United States, and halftone plates representing typical gaging stations and current meters.

**WATER-SUPPLY PAPER 313.** Water powers of the Cascade Range, Part II, Cowlitz, Nisqually, Puyallup, White, Green, and Cedar drainage basins, by F. F. Henshaw and G. L. Parker. 1913. 170 pages, 16 plates, 12 text figures.

The second of a series of reports dealing with the water powers on rivers flowing from the Cascade Range in Washington and Oregon. Descriptions and maps of the several drainage areas are given, together with plans and profiles of the streams, discharge data, outlines of present hydraulic development, summaries of available power, and short discussions of undeveloped possibilities. The report was prepared in cooperation with the Washington State Board of Geological Survey.

**WATER-SUPPLY PAPER 314.** Surface water supply of Seward Peninsula, Alaska, by F. F. Henshaw and G. L. Parker, with a sketch of the geography and geology by P. S. Smith and a description of methods of placer mining by A. H. Brooks. 1913. 317 pages, 17 plates, 12 text figures.

Presents in detail the results of stream-flow measurements made in Seward Peninsula during the years 1906 to 1910, inclusive. The geography and geology of the peninsula are first briefly described, inasmuch as they have a controlling influence on the run-off, and the occurrence and distribution of the gold placers are summarized in the section devoted to geology. At present the mining of the placer gold is the only incentive to the utilization of the stream flow. Methods and costs of mining are also briefly considered. The illustrations include topographic and geologic maps of Seward Peninsula and plates showing methods of hydraulic mining.

**WATER-SUPPLY PAPER 315.** The purification of public water supplies, by G. A. Johnson. 1913. 84 pages, 8 plates, 1 text figure.

This paper gives a simple and direct statement of the principles governing the purification of water used for domestic purposes and seeks to indicate how best to deal with the various problems involved. It includes a brief account of the sources of water supply, the development of waterworks, water consumption, and the reduction of typhoid fever in the United States. Methods of filtration, sterilization, and softening of municipal waters are discussed in full. Halftone plates and zinc etchings show filtration plants in several cities.

**WATER-SUPPLY PAPER 316.** Geology and water resources of a portion of south-central Washington, by G. A. Waring. 1913. 46 pages, 1 plate, 1 text figure.

The area considered in this report comprises about 5,000 square miles in south-central Washington, including Benton County, the eastern parts of Yakima and Klickitat counties, and the western part of Franklin County. The book contains a reconnaissance map of the area, showing the location of wells and springs and the approximate extent of geologic formations.

**WATER-SUPPLY PAPER 317.** Geology and underground waters of the Wichita region, north-central Texas, by C. H. Gordon. 1913. 88 pages, 2 plates.

This report deals with an area of about 11,000 square miles in north-central Texas, comprising Montague, Clay, Wichita, Wilbarger, Hardeman, Foard, Knox, Baylor, Archer, Jack, Young, Throckmorton, and Haskell counties. It presents the results of an investigation made to determine the geologic conditions with a view to locating water-bearing formations that might be available sources of water, and includes a brief description of the geology and water resources of each county and a geologic sketch map of the area.

**MINERAL RESOURCES OF THE UNITED STATES, calendar year 1911.** Part I. Metals, 1018 pages, 16 text figures; Part II, Nonmetals, 1224 pages, 9 plates, 14 text figures. 1912.

Statistics of the production, importation, and exportation of mineral substances in the United States, including accounts of the chief features of mining progress, comparisons of past and present production and conditions, and the application of the products in the useful arts. A consolidation of 56 advance chapters, each covering a single mining industry or group of allied industries.

**MINERAL RESOURCES OF THE UNITED STATES, calendar year 1912; advance chapters as follows:**

Fuel briquetting, by E. W. Parker. 1913. 10 pages.

The production of slate, by A. T. Coons. 1913. 20 pages.



- The production of mica, by D. B. Sterrett. 1913. 15 pages.  
 The production of abrasive materials, by F. J. Katz. 1913. 15 pages.  
 The production of feldspar and quartz, by F. J. Katz. 1913. 11 pages.  
 The production of graphite, by E. S. Bastin. 1913. 11 pages.  
 The production of sand-lime brick. 1913. 7 pages.  
 The production of chromic iron ore, by J. S. Diller. 1913. 10 pages.  
 The production of anthracite, by E. W. Parker. 1913. 19 pages.  
 The production of bauxite and aluminum, by W. C. Phalen. 1913. 16 pages.  
 The production of fluorspar and cryolite, by E. F. Burchard. 1913. 9 pages.  
 Statistics of the pottery industry in the United States, by Jefferson Middleton. 1913. 16 pages.  
 Potash salts: Summary for 1912, by W. C. Phalen. 1913. 36 pages.  
 Gems and precious stones, by D. B. Sterrett. 1913. 42 pages.  
 Precious and semiprecious metals in the Central States (mine production), by B. S. Butler and J. P. Dunlop. 1913. 87 pages.  
 The production of barytes, by J. M. Hill. 1913. 8 pages.  
 The production of peat, by C. A. Davis. 1913. 7 pages.  
 The production of fuller's earth, by Jefferson Middleton. 1913. 8 pages.

**GEOLOGIC FOLIO 184.** Description and maps of the Kenova quadrangle, comprising 938 square miles in Boyd, Carter, Elliott, Greenup, and Lawrence counties, Ky., Lawrence County, Ohio, and Wayne County, W. Va., by W. C. Phalen. 1912. 16 folio pages of text, 3 maps, 13 text figures. Published also in octavo form, 122 pages; maps in pocket.

**GEOLOGIC FOLIO 185.** Description and maps of the Murphysboro and Herrin quadrangles, comprising 471 square miles in parts of Williamson, Jackson, Franklin, and Perry counties, Ill., by E. W. Shaw and T. E. Savage. 1913. 15 folio pages of text, 6 maps, 13 text figures.

**GEOLOGIC FOLIO 186.** Description and maps of the Apishapa quadrangle, comprising 944 square miles in Las Animas, Pueblo, Otero, and Huerfano counties, Colo., by G. W. Stose. 1913. 12 folio pages of text, 3 maps, 13 plates, 21 text figures. Published also in octavo form, 87 pages; maps in pocket.

**GEOLOGIC FOLIO 187.** Description and maps of the Ellijay quadrangle, comprising 980 square miles in Dawson, Fannin, Gilmer, Lumpkin, Pickens, and Union counties, Ga., Cherokee County, N. C., and Polk County, Tenn., by Laurence La Forge and W. C. Phalen. 1913. 17 folio pages of text, 4 maps, 1 columnar section sheet, 7 text figures.

**TOPOGRAPHIC MAPS as follows:**

Alabama (State).	Barnes Bridge, Tex. <sup>1</sup>
Alaska, showing mineral deposits.	Brandywine, Md. <sup>1</sup>
Antlers, Okla. <sup>1</sup>	Buckfield, Maine.
Arkansas (State).	Buckholtz, Tex.
Ashby, Minn.	Buena Vista Lake, Cal.
Ashton Bridge, Tex.	Canton, Ill.
Aurora, Mo.	Carrollton, Ohio.
Bald Knob, W. Va.	Castle Rock, Colo. <sup>1</sup>
Ballarat, Cal.-Nev. <sup>1</sup>	Cedar Lake, Wash.
Bishop, Cal.	Central City, Colo. <sup>1</sup>
Boston sheet (K 19) of International map of world.	Chelsea, Mont.
	Chico Landing, Cal.

<sup>1</sup> New edition.



Chokio, Minn.	Millikin, La.
Coalinga, Cal.	Missoula, Mont.-Idaho.
Colchester, Ill.	Mogollon, N. Mex.
Columbus, Ohio.	Monterey, Cal.
Courtney, Tex.	Moon Lake, Miss.
Crossville, Tex.	Morris, Minn.
Delaware (State).	Moses Lake, Wash.
Durham, Cal.	Mount Hood, Wash.
Flagstaff, Ariz.	Newell, S. Dak.
Galena, Ill.	New Jersey (State).
Georgia (State).	Nord, Cal.
Gettysburg battlefield and vicinity, Pa.-Md.	North Carolina (State).
Hagerstown, Md.-Pa.	Nortonville, Ky.
Hahns Peak, Colo.	Oak Hill, Ohio.
Halsey, Oreg.	Ohio (State).
Hay Creek, Mont.	Palermo, Cal.
Hilliards, Pa.	Panoche, Cal.
Holden, W. Va.	Pella, Iowa.
Hollywood, Miss.	Pennington, Cal.
Hot Springs and vicinity, Ark. <sup>1</sup>	Petrified Forest, Ariz.
Howth, Tex.	Point Lookout, Md.-Va. <sup>1</sup>
Indiana (State).	Poplar, Mont.
Iowa (State).	Prairie Creek, Cal.
Jaegar, W. Va.	Priest Lake, Idaho-Mont.
Kauai, Hawaii.	Queen City, Mo.
Kimmswick, Ill.	Randolph, Utah-Wyo.
Lake Cormorant, Miss.-Tenn.	Rockwall, Tex.
Lansing, Mich.	Roosevelt, Ariz. <sup>1</sup>
Lowville, N. Y.	Salinas, Cal.
Lula, Miss.	Skowhegan, Maine.
McCalls Ferry, Pa.-Md.	Smoke Creek, Mont.
Magdalena district, N. Mex.	Tennessee (State).
Marlas Pass, Mont.	Waterloo, Ill.
Mariposa, Cal.	Weaverville, Cal.
Marysville Butte, Cal.	Wendell, Minn.
Matewan-Williamson, W. Va.	Williamsport, Md.-Pa.
Michigan (State).	Wilson Point, La.
Milan, Ill.-Iowa.	Wisconsin (State).
Millican, Tex.	Zurich, Mont.
Millikens Bend, La.	

#### CHANGES IN ORGANIZATION.

The principal formal change in organization during the year was the separation, in August, of the division of disbursements and accounts into two divisions—the division of disbursements and the division of accounts. J. D. McChesney remains as the chief of the former division and B. S. Favorite was designated as chief of the division of accounts.

On November 16, 1912, Waldemar Lindgren resigned as chief geologist to accept the Rogers professorship of economic geology in the Massachusetts Institute of Technology, and David White, previously in charge of the section of eastern fuel investigations, was appointed to fill the position. Mr. Lindgren continues to give a portion of his time to the work of the Survey. Since the resignation of Mr. Lindgren from continuous service in the Survey the section of metalliferous deposits has been in charge of F. L. Ransome, geologist, and the section of metal resources has been in charge of H. D. Mc-

<sup>1</sup> New edition.

Caskey. Since the resignation of F. B. Van Horn, July 31, 1912, to engage in private work, the section of nonmetalliferous deposits has been in charge of Hoyt S. Gale, geologist.

Early in the fiscal year G. H. Ashley was appointed administrative geologist, although still retaining his connection with land-classification work. He continues to act as chairman of the coal board, C. E. Leshner having been named as vice chairman of this board.

On June 3, 1913, M. O. Leighton resigned as chief hydrographer in charge of the water-resources branch to engage in private practice. N. C. Grover, previously chief engineer of the land-classification board, was appointed to fill the vacancy, as chief hydraulic engineer. During the year district offices have been opened in Tacoma, Wash., with Glenn L. Parker in charge, and in Santa Fe, N. Mex., with Glenn A. Gray, engineer in charge. No appointment as chief engineer of the land-classification board has been made, but the greater part of Mr. Grover's former duties have devolved upon Herman Stabler.

On account of the increase in work in the Pacific division of the topographic branch, due to increase in State cooperation in water-power investigations and in other features, a reorganization of that division was made in July, 1912, into two divisions—the northwestern division, including Washington, Oregon, and Idaho, and the Pacific division, including California, Arizona, Utah, Nevada, and Hawaii. T. G. Gerdine was made geographer in charge of the northwestern division and G. R. Davis geographer in charge of the Pacific division.

On December 26, 1912, W. D. Wirt, the clerk in charge of the section of distribution, was assigned to special work of local sales of maps and folios and J. P. Benfer was placed in temporary charge of the section. On March 12, 1913, H. L. Hill, chief of the executive division, was transferred to temporary service in charge of the section of distribution and Guy E. Mitchell, the Director's secretary, was placed in temporary charge of the executive division.

## GEOLOGIC BRANCH.

### ADMINISTRATION.

The geologic branch embraces four divisions—(1) geology, David White in charge; (2) Alaskan mineral resources, A. H. Brooks in charge; (3) mineral resources, E. W. Parker in charge; and (4) chemical and physical researches, G. F. Becker in charge.

The scope of these divisions is well established, and although they are largely autonomous, they cooperate effectively in their several lines of work. Many of the statistical reports of the division of mineral resources are prepared by geologists in the division of geology, who

are especially familiar with the several subjects. During the field season members of the land-classification board are enrolled in the field parties of the geologic branch that are engaged in work in the public-land States.

The chief geologist gives consideration to the needs of the various regions; makes arrangements, subject to the approval of the Director, for geologic investigations carried on by the Survey in the United States; and has general supervision of the field work. He gives special attention to cooperation in geology with the State surveys and is the executive officer of the branch. On November 16 Waldemar Lindgren resigned as chief geologist to accept the Rogers professorship of economic geology in the Massachusetts Institute of Technology, and David White, previously in charge of the section of eastern fuel investigations, was appointed to fill the position. Mr. Lindgren continues to give a portion of his time to the work of the Survey, which thus still has the benefit of his distinguished professional learning and experience.

The administrative duties of the chief geologist leave but little opportunity for systematic investigations either in the field or in the office, the greater part of his time for field work being occupied in inspecting the work of the parties, in planning future examinations, in field conferences for the determination of questions in dispute, and in supervising the work of the section of eastern fuels.

#### PUBLICATIONS.

The publications of the fiscal year 1913 prepared in the geologic branch consisted of 1 monograph, 5 professional papers, 18 bulletins, 5 advance chapters from 2 economic bulletins, 1 water-supply paper, 1 annual report on mineral resources (1911), 18 advance chapters from Mineral Resources for 1912, and 4 geologic folios. Titles and brief notices of these publications are given on pages 14-22, 26-27.

Besides these publications, 69 papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies. In view of the importance of many of these shorter papers and the generally overtaxed capacity of the professional periodicals and scientific-society publications of high rank, provision was made at the close of the year for the publication of the more important of these scientific papers, including such as are complete in form, are of general interest, and do not require elaborate illustration, in a set of short professional papers to be known as "Contributions to general geology." It is expected that the publication of these papers, many of which contain very valuable scientific material, some of it a by-product of investigations that are primarily economic, will greatly stimulate the scientific work of the Survey

by encouraging broader and more thorough observation and deduction on the part of the geologist, and by affording a very prompt and adequate means for the dignified publication of valuable scientific results.

The areas covered by geologic maps published by the Survey to date and the general nature of the work are indicated on Plate I. It is to be borne in mind that in a number of cooperating States of the East the reports, with maps, have been transmitted for publication by the States.

#### DIVISION OF GEOLOGY.

##### ORGANIZATION.

The scientific force at the beginning of the year consisted of 59 geologists, 25 associate geologists, 39 assistant geologists, and 17 junior geologists. During the year three members of the scientific staff resigned to take places elsewhere at higher salaries and three members were appointed, the total number of geologists of various grades employed at the end of the year being 140. Of this number, 75 were continuously employed, 30 were carried on the per diem roll, giving only a part of their time to the Survey work, and 35 were not employed during the year. In addition to this force, 16 geologic aids were employed as field assistants for a part of the year.

The division was reorganized July 1, 1912, in sections as follows:

1. Section of eastern areal and structural geology (east of the one hundredth meridian). Subsection, investigation of the geology of the Coastal Plain.
2. Section of western areal and structural geology (west of the one hundredth meridian). Subsection, investigations relating to petrography.
3. Section of glacial geology.
4. Section of paleontology and stratigraphic geology.
5. Section of economic geology, metalliferous deposits.
6. Section of economic geology, nonmetalliferous deposits.
7. Section of economic geology, eastern mineral fuels (east of the one hundredth meridian).
8. Section of economic geology, western mineral fuels (west of the one hundredth meridian).

##### ALLOTMENTS.

The total appropriations available for geologic work of the Survey in the United States for the fiscal year 1912-13 were:

Geologic surveys .....	\$300, 000
Statutory salaries .....	17, 700
Search for potash deposits (part of appropriation for chemistry and physics) .....	18, 000
	<hr/>
	335, 700

The allotments of the appropriations were as follows:

Section of eastern areal geology-----	\$31, 500
Subsection of geology of coastal plain-----	15, 000
Section of western areal geology-----	36, 500
Section of glacial geology-----	7, 000
Section of paleontology and stratigraphy-----	24, 000
Section of geology, metalliferous deposits-----	36, 500
Section of geology, nonmetalliferous deposits, including potash-----	28, 000
Section of economic geology, western fuels-----	34, 000
Section of economic geology, eastern fuels-----	21, 000
Débris investigations and inspection-----	2, 500
Supervision, administration, salaries of clerical, technical, and skilled-labor force, supplies, and contingent fund---	74, 700
	<hr/> 310, 700

The above table shows that \$236,000 was expended directly for geologic work, including the search for potash. Of this amount \$100,732, or 42.5 per cent, was expended east of the one hundredth meridian and \$135,268 west of that line. The allotment for supervision, etc., was divided in the same proportion between the eastern and the western work. The balance of the appropriations (\$25,000) was allotted by the Director to the land-classification board, and as the work of the board relates to the Western States only the total amount expended on account of the public-land States was 60.4 per cent of the total appropriation.

#### COOPERATION WITH FEDERAL BUREAUS AND STATE SURVEYS.

The cooperative funds expended during the fiscal year 1912-13 were as follows:

General Land Office, for coal classification-----	\$35, 000. 00
General Land Office, classification of Northern Pacific land grant-----	155. 64
Indian Office, classification of land in Indian reserva- tions, Montana, Washington, Oklahoma, California, and Idaho -----	11, 024. 25
Department of Justice (reimbursements)-----	556. 12
Cooperation with States and official organizations-----	3, 750. 00
	<hr/> 50, 486. 01

The money allotted by the General Land Office (\$35,000) was expended west of the one hundredth meridian, being assigned to the section of western fuels for use in the classification of coal and oil lands.

Since last year, agreements for cooperation in geologic investigations have been entered upon by the State geological surveys of Virginia and Minnesota and by the Oregon Bureau of Mines and Geology. Cooperation in the collection and study of deep-well records

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and drill samples is carried on by the State Geological Survey of Illinois and by the Bureau of Economic Geology and Technology of the University of Texas. An arrangement with the Bureau of Mines for cooperation in the metallographic study of ores is effective July 1, 1913. In the cooperative agreements for geologic work with the States of Maryland, Alabama, Illinois, Minnesota, and Missouri it is provided that the funds contributed by the States shall be handled by the local organization. In the cooperative agreements with Oklahoma, Oregon, Maine, Virginia, and Tennessee the cooperative funds contributed by the States have been disbursed by the United States Geological Survey.

This Survey also cooperates with the Smithsonian Institution and the Isthmian Canal Commission in the study of geologic problems of the Canal Zone under arrangement by which the Survey makes chemical analyses, makes paleontologic investigations and reports, and provides thin rock sections for petrologic examination. In several lines of research there is informal cooperation with the Carnegie Geophysical Laboratory.

#### GENERAL FEATURES OF THE WORK.

The general duty of the division is to prepare a geologic map of the United States, to classify public lands, to make investigative surveys of mineral deposits, and to undertake such geologic and paleontologic researches as may be connected with this work. The preparation of a geologic map includes both detailed and reconnaissance investigations. Research work in petrology, mineralogy, and paleontology is absolutely indispensable, for without it the geologic work degenerates and the product becomes weak and superficial. It is suicidal to separate the so-called scientific work from work of immediate practical utility.

Many problems that arise must be solved by specialists; such are, for instance, those concerning coal deposits or metalliferous deposits and questions of physiography, paleontology, petrology, or glaciology. It would, however, be most unwise to limit too strictly the scope of the work of those chiefly interested in one subject. Thus a geologist studying the mineral deposits of a given area should be expected not to confine himself to this narrow subject, but to extend his investigations into stratigraphy and structure. He may require the aid of other specialists if the problems should prove to be unusually complex. The geologists of the Survey, even those who specialize in certain subjects, must be men of general experience and such breadth of view as to enable them to handle satisfactorily the various problems in one area.

The geologic work of the division, both in the field and in the office, is under the immediate supervision of the chiefs of the respective sections, who are directly responsible for maintaining efficiency and a high scientific standard of work. Exceptions are made of the studies of detrital deposition in California, carried on by G. K. Gilbert under the joint auspices of the geologic and water-resources branches, and the general monographic description of the geology of the Yellowstone National Park, in progress by Arnold Hague. The work of both of these distinguished senior geologists of the Survey is reported directly to the chief geologist.

The relations between the ten sections and subsections of the division of geology are to some extent difficult to define with accuracy because their fields of operation overlap in various ways. The points of overlap are, however, places of teamwork rather than of discordance or conflict, the spirit of the organization being admirable.

During the year services, varying in extent, have been rendered by the geologists of this division to the Office of Indian Affairs in the classification of Indian lands; to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands; to the commission having in charge the establishment of Appalachian forest reserves in accordance with the provisions of the Weeks Act; to the Isthmian Canal Commission with respect to the geologic structure, stability, and resources of the Canal Zone; to the War Department as to depth and adequacy of possible underground water supplies at several points in Texas; and to the Post Office Department in connection with the investigation of fraudulent mining promotion. The Department of Justice has made frequent demands on the services of the geologists of the Survey in connection with the prosecution of suits regarding the public lands.

#### SCOPE OF THE WORK OF THE SECTIONS.

The scope of each of the several sections of the division of geology may briefly be outlined in the following synopsis. The demands made by administrative and committee work, conferences and inspection of field work in different regions, leave to the geologists in charge of the sections very little opportunity for individual work on independent projects, yet some such investigation has been carried forward by each chief of section, as will be noted in the description by States of the work of the division.

1. The section of eastern areal geology—Arthur Keith, geologist in charge—conducts reconnaissance and detailed work in areal or general geology in regions east of the one hundredth meridian, the primary object of which is to make known, mainly through folios of the geologic atlas, the general geology of the region studied, or to prepare scientific and educational descriptions of it, rather than to

examine and describe or map the area especially on account of some particular economic resource. The work of this section is carried on in close cooperation with several State surveys and university departments of geology, an effort being made to coordinate the work of all participants.

During the year work in the section of eastern areal geology has been carried on by Arthur Keith, D. B. Sterrett, L. M. Prindle, F. B. Laney, B. K. Emerson, F. Bascom, F. J. Katz, C. D. Smith, W. B. Clark, B. L. Miller, R. H. Wood, H. D. Miser, and others, on projects affecting the States of Alabama, Arkansas, Delaware, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, and Virginia.

2. The subsection of Coastal Plain investigations—T. W. Vaughan, geologist in charge—was restored in June to its former rank of section. It is occupied primarily with the study of the numerous geologic formations of the Atlantic and Gulf Coastal Plain, their character, extent, equivalence, general structure, conditions of deposition, and history, and of the underground water and other mineral resources of the region. Most of the areal work of this section during the last year has been reconnaissance work. Its office investigations are comprehensive and broadly scientific as well as economic.

In connection with the study of the formations and fossils of the Coastal Plain region and of the Isthmian Canal Zone it has been found possible, through the cooperation of several organizations and individuals, including the Carnegie Institution, the Smithsonian Institution, the Bureau of Fisheries, J. B. Henderson, and others, to accumulate and coordinate very important data that are indispensable for the correlations of the eastern formations with those of the Pacific coast, and invaluable in working out the geologic history not only of the Gulf Coastal Plain but of the Central American and Antillean regions. In addition to the work of the geologists, T. W. Vaughan, W. H. Dall, L. W. Stephenson, G. C. Matson, Alexander Deussen, E. W. Berry, and C. W. Cooke, who have given at least a part of their time to the work of this section, the section has received cooperative aid from J. A. Cushman, who has continued his studies of the Cretaceous and Tertiary Foraminifera of North America; from R. S. Bassler, of the National Museum, and F. Canu, of Versailles, France, who are monographing the Tertiary Bryozoa of the Coastal Plain; from Miss M. J. Rathbun, of the National Museum, who is describing the Crustacea of the same formations; from the Bureau of Fisheries, in the examination of the sediments about the Mississippi Delta; and from the Smithsonian Institution, in the investigations of the Canal Zone, the calcareous algæ of which are being studied by M. A. Howe, of New York, the echinoids by W. B. Clark, of Johns Hopkins

University, and the fossil vertebrates by J. W. Gidley, of the National Museum.

The field and office researches of the section concern all the coastal States from Virginia to Texas, inclusive, together with Arkansas, Tennessee, Kentucky, Indiana, and Illinois, also the Canal Zone.

3. The work of the section of western areal geology (west of the one hundredth meridian)—F. L. Ransome, geologist in charge—corresponds to that of the section of eastern areal geology and is similar in scope, these sections being especially charged with the preparation of the folios of the geologic atlas of the United States.

On account of the wide distribution and the great diversity of igneous and metamorphic rocks requiring petrologic study for classification and correlation in this province, the subsection of petrologic investigations—E. S. Larsen, jr., associate geologist in charge—is attached to the section of western areal geology, although it is responsible for the petrologic examinations of rocks, revision of manuscripts relating to petrology, and all other petrologic work for the division of geology.

The following geologists, among others, have done work in the section of western areal geology during the year: F. L. Ransome, Whitman Cross, J. S. Diller, Sidney Paige, N. H. Darton, Adolph Knopf, G. B. Richardson, Geo. I. Finlay, F. C. Calkins, W. H. Emmons, A. C. Lawson, Eugene Stebinger, L. G. Westgate, J. B. Umpleby, R. W. Richards, G. R. Mansfield, D. F. Hewett, E. L. Jones, jr., P. V. Roundy, E. S. Larsen, J. F. Hunter, W. W. Atwood, and H. G. Ferguson.

The activities of the section have concerned the States of California, Colorado, Idaho, Montana, New Mexico, South Dakota, Texas, Utah, Wyoming, and the Hawaiian Islands.

4. The section of glacial geology—W. C. Alden, geologist in charge—is engaged in the study of the work of the great glaciers, the glacial deposits and the contemporary deposits of the bordering regions, and the geologic history of the continent during the Pleistocene epoch. The geologists occupied with these varied and specialized problems are responsible for the classification and mapping of the Pleistocene deposits of the glaciated regions.

The work of this section during the year has engaged the services of W. C. Alden, Frank Leverett, F. W. Sanderson, F. B. Taylor, N. M. Fenneman, and Eugene Stebinger, and has comprised field studies and mapping and the preparation of reports touching areas in the States of Maine, Massachusetts, Minnesota, Montana, and New York.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist in charge—is responsible for the determination of the relative ages of the various sedimentary formations, for the correlation of the strata in different areas, and for the reference of the forma-

tions to a geologic time scale. The paleontologists are engaged also incidentally in working out the sequence and characters of the continental changes, the physiographic and climatic conditions of the various periods, and the history of the animal and plant life of the geologic epochs. This is accomplished through the patient study of the remains of animals and plants of innumerable kinds found fossilized in the different sedimentary formations. The field study of the stratigraphic distribution of the fossil floras and faunas gives the most complete key to the correlation of the beds; hence the paleontologists can most efficiently accomplish their work by close cooperation with the areal and economic geologists.

The work in this section, which includes the services, for at least portions of the year, of T. W. Stanton, W. H. Dall, E. O. Ulrich, F. H. Knowlton, G. H. Girty, E. M. Kindle, H. S. Williams, J. P. Smith, E. T. Kirk, and others, is practically coextensive with that of the division of geology and of Alaskan mineral resources, and is indispensable to the geologic mapping of the areas surveyed and the satisfactory determination of the structure.

The reports of the paleontologists are usually comprehensive. A single manuscript may embody the results of portions of the work done in aid of geologists in several sections scattered over a wide area of the country. Very often fossil material from several States and regions will be under examination at once by a paleontologist; hence, in the account of the work of the branch by States, mention will be made only of those in which the paleontologist is making a special and somewhat circumscribed study.

6. The section of metalliferous deposits not only studies metalliferous deposits and mines and investigates the conditions and methods of ore deposition, but also carries on reconnaissance geologic examinations of many districts and makes complete detailed areal surveys, for folio publication, of quadrangles in which metalliferous deposits are of special importance, the folios being subject to the inspection and approval of the geologists in charge of areal geology.

Since the resignation of Waldemar Lindgren from regular service in the Survey, November 16, 1912, this section has been in charge of F. L. Ransome, geologist. The numerous duties attached to the administration of this section and the section of western areal geology leave little opportunity to the geologist in charge for original investigation. Valuable scientific work has, nevertheless, been accomplished in connection with the field conferences and inspections of the work in different areas. Field and office work in this section has been done by Waldemar Lindgren, F. L. Ransome, A. C. Spencer, W. H. Emmons, F. B. Laney, C. E. Siebenthal, E. F. Burchard, E. S. Bastin, B. S. Butler, F. C. Calkins, E. L. Jones, jr., H. G. Ferguson, F. L. Hess, Adolph Knopf, Edwin Kirk, G. F. Loughlin,



F. C. Schrader, J. M. Hill, J. F. Hunter, jr., J. B. Umpleby, J. T. Pardee, R. W. Stone, and J. D. Irving on projects which will be referred to in the description of the investigations of the division in the States of Alabama, Arizona, California, Colorado, Georgia, Idaho, Missouri, Montana, Nevada, New Jersey, Oklahoma, Tennessee, Utah, Washington, and Wyoming, and Dutch Guiana.

7. The section of nonmetalliferous deposits is concerned with the examination of the deposits of nonmetallic ores and minerals, exclusive of fuels, and with the geologic investigation and mapping of regions in which such minerals or ores are of paramount importance. Among the more important of the mineral resources with which the section is especially concerned are clay, cement rock, limestone, salt, borax, phosphate, sand, and building stone.

This section is administratively like the section of metalliferous deposits or the fuel sections. Since the resignation of F. B. Van Horn, July 31, 1912, to engage in private work, the section has been in charge of H. S. Gale, geologist.

During the year the greater part of the work of the section has been divided between the search for potash in commercial quantities in the salts of the old evaporation basins or dried-up ancient lakes of the Southwest and classification of the phosphate-bearing lands withdrawn from entry in Idaho, Wyoming, and Montana.

Work in this section has been performed by H. S. Gale, W. C. Phalen, R. W. Richards, G. R. Mansfield, J. H. Hance, E. H. Finch, Eliot Blackwelder, and C. E. Watson as described on later pages, in the States of Arizona, California, Georgia, Idaho, Montana, Nebraska, Nevada, New Mexico, Tennessee, and Utah.

8. The section of eastern fuels—David White, geologist in charge—conducts examinations of coal, oil, and gas bearing areas in regions east of the one hundredth meridian. It not only investigates and describes the economic geology, but often also works out the detailed areal geology for folio publication, the folios being subject to the inspection and approval of the geologist in charge of the section of eastern areal geology.

The work in this section during the year has been confined mainly to the study of coal, oil, and gas areas in cooperation with the State surveys of Pennsylvania, Virginia, Illinois, Tennessee, Missouri, and Oklahoma. Noncooperative work has been carried on in Ohio, Kentucky, Kansas, Alabama, West Virginia, Massachusetts, Louisiana, and Texas. The following geologists participated in the activities of the section: David White, G. H. Ashley, Charles Butts, M. J. Munn, E. W. Shaw, G. C. Matson, Henry Hinds, R. H. Wood, D. D. Condit, C. A. Davis, and F. C. Green, the aid of the two last named being given respectively through the courtesy of the Bureau of Mines and the Bureau of Geology and Mines of Missouri.

9. The section of western fuels—M. R. Campbell, geologist in charge—conducts examinations and surveys in the fuel-bearing areas west of the one hundredth meridian similar to those carried on by the section of eastern fuels. The greater part of the work of the western section has consisted in classifying and mapping coal or oil bearing lands in North Dakota, South Dakota, Montana, Wyoming, Colorado, New Mexico, Utah, Washington, Oregon, Idaho, and California. Work in this section, a part of which was done on the quadrangle basis for folio publication, subject to the approval of the geologist in charge of the section of western areal geology, has been performed by the following geologists: M. R. Campbell, E. G. Woodruff, M. A. Pishel, F. A. Herald, C. M. Bauer, E. M. Parks, D. E. Winchester, E. R. Lloyd, C. J. Hares, G. S. Rogers, H. M. Robinson, C. F. Bowen, H. S. Bassler, Eugene Stebinger, V. H. Barnett, D. F. Hewett, C. H. Wegemann, A. L. Beekly, E. T. Hancock, W. T. Lee, F. R. Clark, C. T. Lupton, M. W. Ball, J. H. Hance, C. A. Bonine, G. B. Richardson, Robert Anderson, R. W. Pack, R. G. Davies, and C. E. Leshner.

#### ASSISTANCE TO OTHER DIVISIONS.

In addition to the work done in their respective sections a considerable number of the geologists in the sections of metalliferous and nonmetalliferous deposits and several geologists in the sections of eastern and western areal geology and western fuels have prepared for publication in the annual volumes of Mineral Resources reports of the production and statements of the industrial conditions of a large number of mineral resources with which they are especially familiar. Portions of the salaries of some of these geologists are paid from the funds of the division of mineral resources; for others the traveling and field expenses necessary for the collection of data are paid from the funds of that division. As a result of this cooperation between the two divisions, the value of the reports, which will be enumerated in the report of the chief of the division of mineral resources, has been greatly increased, while the contributing geologists have, at the same time, acquired a wider commercial knowledge of the particular mineral deposits and industry.

The paleontologists of the division of geology report on all fossil collections for the division of Alaskan mineral resources, and a part of the time of several of the geologists is given to the land-classification board. Constant interchange of information is made with the water-resources branch.

#### COMMITTEE ON GEOLOGIC NAMES.

An important standing committee of the geologic branch is the committee on geologic names, which consists of T. W. Stanton (chairman), M. R. Campbell (vice chairman), W. C. Alden, G. H.



Ashley, Arthur Keith, F. L. Ransome, G. W. Stose, and David White. The clerical work of the committee is performed by Miss M. G. Wilmarth, who is designated secretary.

According to the Director's instructions of January 30, 1909, "It is the duty of the committee on geologic names to consider all geologic names used by members of the Geological Survey in both official and unofficial publications. When manuscripts are received by the committee they shall be examined as soon as practicable and the committee shall decide whether the names employed are permissible or not."

The chief objects of the committee are to insure uniformity in geologic classification and nomenclature in survey publications, to prevent unnecessary duplication of geologic names, and to reduce if possible the number of names employed, through correlation of the formations from one area to another. The main criteria on which the decisions of the committee are based are priority of publication, significance acquired by usage, and adequacy of definition and type locality. No one of these criteria is relied on to the exclusion of the others.

The records of the committee comprise (1) a catalogue of geologic names considered by the committee, arranged alphabetically, the action taken for each manuscript being recorded; (2) a catalogue of American geologic names in the literature, also arranged alphabetically, each published description of a formation being recorded (this catalogue is the work of J. M. Nickles, of the library staff); (3) a catalogue of the geologic names in the literature, arranged by States; (4) a catalogue of geologic columnar sections approved by the committee, arranged by States, the area to which each columnar section applies being located on the appropriate State map diagram; and (5) a catalogue of geologic columnar sections in the United States, classified by States, compiled from existing literature, the areas being located on a set of State maps. The last catalogue is not complete, but is being brought up to date as rapidly as possible. It is designed to prevent unnecessary duplication of geologic names. All these records, except as noted above, have been prepared and are kept up to date by the secretary of the committee.

During the year the committee on geologic names has considered 181 manuscripts, comprising 15,207 pages and involving about 2,600 geologic names.

#### WORK OF THE DIVISION BY STATES AND COUNTRIES.

The work done by the division of geology during the year affected the 45 States listed below, the Canal Zone, Dutch Guiana, and the Hawaiian Islands:

Alabama.	Maryland.	Ohio.
Arizona.	Massachusetts.	Oklahoma.
Arkansas.	Michigan.	Oregon.
California.	Minnesota.	Pennsylvania.
Colorado.	Mississippi.	South Carolina.
Delaware.	Missouri.	South Dakota.
Florida.	Montana.	Tennessee.
Georgia.	Nebraska.	Texas.
Idaho.	Nevada.	Utah.
Illinois.	New Hampshire.	Vermont.
Indiana.	New Jersey.	Virginia.
Kansas.	New Mexico.	Washington.
Kentucky.	New York.	West Virginia.
Louisiana.	North Carolina.	Wisconsin.
Maine.	North Dakota.	Wyoming.

## ALABAMA.

The field investigations of the red-ore deposits of northeastern Alabama were completed by E. F. Burchard in June. This work connects that done in the Birmingham region, described in Bulletin 400, with the studies of the red iron ores of eastern Tennessee, recently contributed for publication by the Tennessee State Geological Survey, and a short preliminary report on the work was prepared for "Contributions to economic geology, 1912, Part I" (Bulletin 540-G).

A brief inspection of the formations and structure in the Columbiana quadrangle was made early in the spring by Arthur Keith and Charles Butts, who found the "Ocoee" strata thrust many miles over the younger Paleozoic formations. The manuscripts and maps for the Bessemer-Vandiver and Montevallo-Columbiana folios have been prepared by Mr. Butts and submitted for publication.

A brief examination was made of several reported oil prospects in the northern part of the State. The conclusions will be reported in a bulletin on the southern Appalachian oil and gas fields now in preparation by M. J. Munn.

The manuscript for a professional paper on the fossil floras of the Tuscaloosa, Eutaw, and Ripley formations of the eastern Gulf region has been transmitted by E. W. Berry.

A special report on the prospects for underground water at Troy was prepared by L. W. Stephenson and transmitted to the municipal executive of that city.

## ARIZONA.

A short paper on the Superior copper district, Ariz. (in Bulletin 540-D), has been completed by F. L. Ransome, who has made progress on the report on the Ray and Miami copper districts. Mr. Ransome has also prepared brief papers on the Bisbee, Globe, Miami, Ray, and Jerome districts for inclusion in the bulletin by W. H.

Emmons on sulphide enrichment (Bulletin 529), and has in hand a report on the Tombstone district and a folio on the Ray quadrangle. Mr. Ransome is accumulating material for a paper on the geology and ore deposits of Arizona.

The deposits of celestite in Maricopa County was examined by W. C. Phalen and has been described in a paper submitted for publication in "Contributions to economic geology, 1912, Part I" (Bulletin 540-T).

The mineral deposits of the Santa Rita and Patagonia mountains in the Patagonia and Nogales quadrangles have been somewhat fully described by F. C. Schrader in a bulletin submitted for publication.

Two short papers, one by J. M. Hill, entitled "Copper deposits of the White Mesa district, Arizona" (in Bulletin 540-D), and the other by F. C. Schrader, describing a newly recognized occurrence of alunite near Patagonia (in Bulletin 540-I), have been submitted for publication.

#### ARKANSAS.

The geology of the DeQueen quadrangle, Ark., was areally mapped for folio publication by H. D. Miser, assisted by R. D. Messler. Portions of the maps of the Caddo Gap and Hot Springs quadrangles were revised by Mr. Miser, the work being necessary for the completion of folios for these two quadrangles under joint authorship of Mr. Miser and A. H. Purdue. Mr. Miser also prepared for publication in the "Contributions to economic geology, 1912, Part I" (Bulletin 540-U), a short description of the new diamond localities in Arkansas.

A bulletin on the fauna of the Batesville sandstone was submitted by G. H. Girty for publication, and paleontologic examinations of the older Paleozoic formations in the Ozark region were made by E. O. Ulrich.

Additional studies of the stratigraphy, structure, and physiography of parts of eastern and northeastern Arkansas were made by L. W. Stephenson, who also made supplemental studies of the Cretaceous rocks in southwestern Arkansas. A report on the underground waters of the eastern part of the State, by Mr. Stephenson and A. F. Crider, formerly a geologist of the Survey, is now practically complete, though its submittal is delayed pending the preparation of a chapter by R. B. Dole, of the water-resources branch, on the chemistry of the waters.

#### CALIFORNIA.

During the field season of 1912 a large part of the Weaverville quadrangle, Cal., was mapped by J. S. Diller, assisted by H. G. Ferguson, for folio publication. Field work in this quadrangle was re-

sumed in June, when incidentally Mr. Diller examined and reported on the classification of the Igo town site, in Shasta County. A preliminary report on the auriferous gravels of the Weaverville quadrangle was prepared and submitted by Mr. Diller, and a report on the gold lodes of the same area was completed by Mr. Ferguson, both for publication in Bulletin 540-A. A reconnaissance study of the gold deposits near Allegheny and Forest, in Sierra County, was made by Mr. Ferguson in May.

The report on the geology and ore deposits of the Randsburg quadrangle, on which F. L. Hess has been engaged, has been much delayed on account of the demand on him for statistical reports on the rare metals for inclusion in the reports of the division of mineral resources.

A detailed reconnaissance of the southern 70 miles of the White Mountain Range, in Inyo County, was made by Adolph Knopf, assisted by Edwin Kirk, who together mapped an area of about a thousand miles on the 1:250,000 scale. A preliminary account of the geology and a detailed description of the mineral resources were embodied in a paper submitted for publication in "Contributions to economic geology, 1912, Part I" (Bulletin 540-B). Two papers by Mr. Knopf on ore deposits were submitted to scientific journals during the year. The paleontologic materials of the region are being studied by Mr. Kirk. A reconnaissance examination of the Darwin silver and lead district was made by Mr. Knopf in May.

As a result of the examinations of several mining camps in the northern part of the State adjacent to Nevada, studied by J. M. Hill, he submitted for publication as a bulletin a short paper entitled "Some mining districts in northeastern California and northwestern Nevada."

The new developments in the magnesite industry in the State were examined by H. S. Gale, who also made a brief study of the borate deposits in Ventura County. Papers embodying the results of this work have been submitted for "Contributions to economic geology" (Bulletin 540, chapters S and O).

In connection with the search for potash, a study of the saline deposits in several of the desert basins of southern California and Nevada was made by Mr. Gale. This review included the region about Carrizo Plain, Owens Valley, Saline Valley, Indian Wells Valley, Searles Lake, Panamint Valley, and Death Valley. Some of the results of these examinations are included in two papers entitled "Notes on the Quaternary lakes of the Great Basin with special reference to potash and other salines" (in Bulletin 540-N) and "Origin of colemanite deposits" (Professional Paper 85-A). These papers have been submitted for publication by the Survey.

The solar salt plants on the California coast were examined by W. C. Phalen and the results of the examination will be included in a paper on the saline deposits of the country. A deposit of celestite in San Bernardino County was also investigated by Mr. Phalen, who has described the occurrence in Bulletin 540-T.

A brief visit to the region north of the Coalinga oil field to obtain data on recent drillings was made in September by Robert Anderson, who spent a few days also in the Elk Hills district investigating the land recently withdrawn as an oil reserve for the Navy.

A detailed study of the geology of the foothills at the south end of the San Joaquin Valley between the Kern River and Temblor Range oil fields was completed by R. W. Pack, assisted by R. G. Davies. Messrs. Pack and Davies also made a reconnaissance examination of an area near Barstow, in the Mohave Desert, and a brief report on this area was submitted for publication as Bulletin 541-E. Near the close of the field season Mr. Pack made a brief reconnaissance of the area lying north of the Kern River oil field and previously withdrawn as possible oil land. A part of this area that is of doubtful value as oil land but of considerable value as agricultural land has been restored to entry. Some time was also spent by Mr. Pack in the Temblor Range and in the Kern River oil fields, obtaining data on recent developments.

A report on the geology and possible oil resources of a part of the Diablo Range by Robert Anderson and R. W. Pack has been submitted for publication. A report on the Kern River oil field is now in preparation by Mr. Pack, who, since the resignation of Mr. Anderson on January 20, has had sole charge of work in the oil fields of the State.

Progress has been made in the study and description of the marine Triassic faunas of California and other Western States by J. P. Smith.

#### COLORADO.

The comprehensive studies of the San Juan Mountain region that for several years have been carried on by Whitman Cross and his associates have this year been continued in the field by E. S. Larsen, jr., assisted by J. F. Hunter, jr. The work consisted in continuing the geologic mapping of a portion of the Ignacio quadrangle, on the south side of the mountains, with a revised topographic base; completing the geologic map of the San Cristobal quadrangle, in the central part of the San Juan Mountains; and surveying the geology of the Uncompahgre quadrangle. Within the area last named are the iron-bearing deposits adjacent to Cebolla Hot Springs. The geology of this district proved to be unusually complex. In conjunction with the investigations by Mr. Cross, office work on reports dealing with the

Pleistocene deposits and history of the Ignacio and San Cristobal quadrangles was performed by W. W. Atwood and his assistant, K. F. Mather.

In the autumn the study of the pre-Cambrian formations adjacent to the Gunnison Canyon, in the northern part of the Uncompahgre quadrangle, was continued by Mr. Hunter. In November Mr. Larsen completed his study of the mining camp at Creede, and in the latter part of June he made an examination of the geology of Wagon Wheel Gap, on the Rio Grande, for a report to the Forest Service on certain areas selected for experiments on the relation of forest cover to run-off. The report on the areal geology of the Creede district has been nearly completed by Mr. Larsen, who, assisted by Mr. Hunter, has been engaged in the preparation of the Uncompahgre folio, working especially on the pre-Cambrian rocks. A paper on the hot springs and mineral deposits of Wagon Wheel Gap was prepared by Mr. Larsen and W. H. Emmons for publication in one of the scientific journals.

Additional observations about the mines at Creede were made by W. H. Emmons, who is preparing a report on the ore deposits of that district. Mr. Emmons is also gathering material for an enlarged and illustrated edition of Bulletin 529, "The enrichment of sulphide ores."

The report on the ore deposits of Leadville, on which J. D. Irving had been engaged with S. F. Emmons at the time of the latter's death in 1911, has been continued under contract by Mr. Irving, but, owing to its interruption by illness and other unfortunate contingencies, this task, which has proved unexpectedly difficult, is still far from complete.

The report on the economic geology of the Central City district, by E. S. Bastin, is now nearly complete. Some time was spent by Mr. Bastin, in collaboration with Chase Palmer, of the division of physics and chemistry, in research on the precipitative action of metallic minerals upon gold and sulphur in solution. A short paper containing some of the results of this investigation was printed in the *Journal of Geology*.

A very brief examination of a portion of the Hardscrabble mining district, in Custer County, was made by J. F. Hunter, jr.

For several years a study of the stratigraphy of the coal-bearing formations of the southern part of the Rocky Mountain region has been prosecuted by W. T. Lee, who has obtained much valuable information regarding the age and correlation of the various formations and the physical conditions under which they were deposited. This work is so important that it was extended northward in the spring of 1913, when Mr. Lee, in association with E. T. Hancock, made a special examination of the geologic formations of the Yampa



coal field. The fossil plants of the region have been studied by F. H. Knowlton, who has submitted reports on the floras of the Raton Mesa coal field of Colorado and New Mexico and on the flora of the Miocene deposits near Florissant.

The southwestern Colorado coal field, a considerable area of which was studied in 1911 by M. A. Pishel for the purpose of mapping the workable coal in the Dakota sandstone, was not visited by Mr. Pishel in 1912, on account of the short period available for field work, but some time has been devoted by him in the office to the preparation of a report on this region which is now well advanced toward completion. Mr. Pishel also contributed to the Coal Age a short paper entitled "The Pishel coking test."

The detailed surveys begun in the Meeker quadrangle in 1911 were continued northward and eastward in 1912 in the Axial and Monument Butte quadrangles, lying partly in the Yampa coal field, in Routt and Moffat counties, the geologic work being done from the camp of the party making a topographic survey of the same area. Although, on account of the great number of coal beds and the voluminous exact data gathered regarding both vertical and horizontal locations and outcrops, the work was laborious and difficult, an area of 298 square miles was examined in great detail by E. T. Hancock, who completed the work on the Axial quadrangle and has prepared a portion of a folio text covering the quadrangle.

A careful reconnaissance survey of North Park was made in order to determine, if possible, the extent of the coal beds and the quality of the coal in the North Park coal field, concerning which the data available had previously been found to be inadequate. Special examinations of the park were therefore made by A. L. Beekly, assisted by George I. Finley, R. S. Bassler, and E. H. Finch, in order to supply necessary material for a report, which was submitted by Mr. Beekly for publication prior to his resignation from the Survey in June. The general stratigraphy and invertebrate paleontology of the region mapped by Mr. Beekly were examined by T. W. Stanton, who also reviewed for the purpose of correlation the formations in several portions of southern Colorado.

A small area in Middle Park was examined by M. R. Campbell to determine whether or not it should be classified as coal land.

The work in the Colorado Springs and Castle Rock quadrangles, for which folios by G. I. Finlay and G. B. Richardson are nearly ready for publication, was inspected by Mr. Ransome.

#### DELAWARE.

The study of the detailed stratigraphy and areal geology of the Elkton and Wilmington quadrangles, Del., has been completed by B. L. Miller, assisted by M. I. Goldman. Through the cooperation



of the Maryland Geological Survey the gneisses and related rocks of these quadrangles have been examined by Florence Bascom.

A paper discussing the underground water supply of the State is under revision.

#### FLORIDA.

The study of the corals and the reefs of Florida, by T. W. Vaughan, has given results of great scientific value. The observations on the rate of growth of these corals are now sufficiently complete to afford accurate information regarding practically all the known Florida reef species, so that it is possible to estimate the rate at which the reefs are growing. Mr. Vaughan discovered that the food of corals, concerning which little was previously known, consists entirely of animal plankton.

Studies of the mode of formation of oolite and of the oolitic limestones, which are abundant in southern Florida and in the Bahamas, have been successfully prosecuted by Mr. Vaughan.

The Foraminifera discovered in various rock sections and in a large number of the samples collected in the course of the Coastal Plain work in the State have been identified by J. H. Cushman. In addition, he has made a preliminary study of the Foraminifera of certain deep wells of Bermuda and of Key West.

The report on the fauna of the "silex beds" of the Tampa formation, which throw much light on the distribution of land animals in the Central American and Carribean regions, as well as in North America, has been completed by W. H. Dall and submitted for publication.

#### GEORGIA.

The red iron ores of northwestern Georgia have been examined by E. F. Burchard and are described in a paper on the red iron ores of east Tennessee, northeast Alabama, and northwest Georgia (Bulletin 540-G).

A very brief examination of the bauxite deposits in the State was made by W. C. Phalen for the purpose of obtaining information for inclusion in a report on the production of bauxite for the division of mineral resources. Some work was done by Mr. Phalen in editing and revising his contribution to the section on economic geology in the *Ellijay folio*.

A report on the underground water resources of the Coastal Plain of the State was prepared by L. W. Stephenson and Otto Veatch, the latter representing the State Geological Survey, in cooperation with which the work was done.

## IDAHO.

Thirteen mining districts in southeastern Idaho, north of Snake River, were covered in a geologic reconnaissance in the summer of 1912 by J. B. Umpleby, who has submitted a preliminary paper on the Dome district (in Bulletin 540-E). Administrative duties in connection with the section of metalliferous deposits and the claims of service on the metalliferous section of the land-classification board have delayed the completion of Mr. Umpleby's final report, which is, however, well advanced. He resumed the study of the ore deposits in June, when he visited the mining districts of the Middle Fork drainage basin, in the central part of the State.

The areal and economic geology of the northeastern part of the area known provisionally as the Taff quadrangle was mapped and studied for folio publication by F. C. Calkins, assisted by E. L. Jones, jr., the work being done from the camp of the party engaged in the topographic survey of the quadrangle. Incidentally opportunity was found to review the mining developments which have taken place since the publication of the report on the Cœur d'Alene district (Professional Paper 62) in the vicinity of Mullan and Wallace, in the area that is common to both the Taff and Cœur d'Alene quadrangles. A preliminary report containing some results of the field work of the season has been prepared by Messrs. Calkins and Jones for publication in "Contributions to economic geology, 1912, Part I" (Bulletin 540-E).

The classification of Northern Pacific Railroad grant lands in T. 49 N., R. 3 W., Boise meridian, listed in 1911, was accomplished by E. L. Jones, jr., who submitted a report. While awaiting the passage of the sundry civil bill, F. C. Calkins spent a short time in adjusting the geologic evidence relating to the contested classification of a part of the Northern Pacific land grant in this State. Later he examined additional areas in the Northern Pacific land grant for classification.

The geologic mapping of the Hailey quadrangle was begun in June, 1913, by L. G. Westgate, who will study the areal and structural geology. The ore deposits of the quadrangle are being examined by J. B. Umpleby, who will extend his work to other mining camps of the region.

A folio to cover the Montpelier quadrangle was completed by R. W. Richards, assisted by G. R. Mansfield, the field work being done in connection with the investigation of the phosphate deposits of the region.

Detailed land-classification surveys in southeastern Idaho have been made by G. R. Mansfield, assisted by E. H. Finch, and reports covering this work have been submitted to the land-classification board

At the request of the Commissioner of Indian Affairs for the classification of the lands in the Fort Hall Indian Reservation the examination of the lands underlain by phosphate-bearing formations was begun by G. R. Mansfield in June.

The invertebrate faunas of the Carboniferous formations in several of the areas under investigation were examined in the field by G. H. Girty, the correlative results being communicated for the use of the areal geologists.

The Hayden coal field, lying southeast of St. Anthony, in Fremont County, was geologically studied by E. G. Woodruff, who collected data sufficient for the classification of the land and who prepared for publication a brief account of its geology and coal resources.

#### ILLINOIS.

In the course of the study of the Illinois coal fields in cooperation with the State Geological Survey the geology of the Centralia quadrangle was mapped by E. W. Shaw and that of the Colchester and Macomb quadrangles by Henry Hinds, who near the close of the field season was assisted by G. S. Rogers. A short report on the economic resources of the two latter quadrangles by Mr. Hinds has been transmitted for publication by the State survey. As a part of the cooperative work the Pleistocene formations in the Waterloo quadrangle were mapped for a geologic folio by Mr. Shaw, who also inspected the Pleistocene of the Colchester and Macomb quadrangles. Later Mr. Shaw extended his studies of the surficial geology and physiography to the south end of the State and to the lower reaches of the Mississippi Valley with a view to correlating the Pleistocene features and formations of the upper Mississippi basin with those of the Gulf embayment. He also prepared a folio manuscript to cover the Carlyle and Centralia quadrangles.

G. H. Girty and E. O. Ulrich made special examinations of the Mississippian formations at several points in the southern part of the State in conferences with cooperating geologists of the Illinois and Missouri geological surveys in order to establish more definitely the interstate correlations of several of the formations.

#### INDIANA.

The Pleistocene deposits of the northern part of Indiana were examined by E. W. Shaw in order to trace the terraces and individual formations southward into the Gulf embayment.

#### KANSAS.

The Pleistocene formations in the vicinity of Leavenworth, Kans., have been examined by E. W. Shaw for mapping in the Leaven-

worth-Smithville folio, now in preparation under a cooperative agreement with the Missouri State Bureau of Mines and Geology.

The zinc deposits in the extreme southeast corner of Kansas have been further investigated by C. E. Siebenthal, and will be discussed in the Wyandotte folio and in a bulletin on the genesis of the ores of the Joplin district.

The fossil floras accompanying the lower coals worked in the vicinity of Mulberry were examined in the field by David White for use in the correlation of the lower Cherokee coals of Kansas and Missouri, and in the determination in this region of the equivalent of the Pottsville in the Cherokee shale.

#### KENTUCKY.

The northwestern third of the Pound quadrangle, recently surveyed in the southwestern Virginia coal field, overlaps across the eastern border into Kentucky. This area, which includes newly opened mines near Jenkins, was surveyed by Charles Butts, who has prepared a description of the structure and coal resources of the quadrangle to be submitted for publication by the Geological Survey of Virginia.

The Mississippian rocks at several points in western Kentucky were visited in a brief reconnaissance by G. H. Girty and E. O. Ulrich, for purposes of correlation, and the Pleistocene deposits of the Mississippi Valley were examined by E. W. Shaw.

A folio (No. 184) covering the Kenova quadrangle was issued early in the year.

#### LOUISIANA.

A preliminary examination of the composition, structure, and mode of growth of the Mississippi Delta was made by E. W. Shaw for the purpose of determining, if possible, the nature and cause of the "mud lumps" which occasionally rise in the mouths of the Mississippi and seriously obstruct navigation. The origin of this phenomenon has not been fully explained. The mud volcanoes and their gas emanations were also considered by Mr. Shaw and have been described by him in a paper in "Contributions to economic geology, 1912, Part II" (Bulletin 541-A). A short description of the mud lumps is soon to be issued in the "Contributions to general geology, 1913" (Professional Paper 85-B). In June, 1913, an opportunity was given, through the courtesy of the Bureau of Fisheries, to Mr. Shaw to collect samples of the bottom muds of the Gulf in the region of the Delta. Representative sediments were selected from a large number of samples for complete chemical analyses.

In the later part of the year the geologic structure in the vicinity of Shreveport, Caddo Lake, Pine Prairie, and several other points in

the northern part of Louisiana was examined by G. C. Matson for the purpose of determining more exactly the relations of the oil and gas to the structure of the rocks, and to discover, if possible, new areas structurally favorable for the occurrence of oil. Reports on this work, which was carried on in connection with studies of the Coastal Plain formation in the State, are now in preparation by Mr. Matson.

A report on the fossil floras of the Oligocene in the State was submitted by E. W. Berry for publication by the Survey.

#### MAINE.

The areal and economic surveys of the Portland and Casco Bay quadrangles, Maine, carried on in cooperation with the State Water Storage Commission, were completed by F. J. Katz, who has made good progress in the preparation of the folio text for these quadrangles. In November he was joined by W. C. Alden for a conference on the Pleistocene deposits in the Portland quadrangle. A preliminary paper by Mr. Katz describing the geology of the Portland region has been prepared for publication in the report of the State commission.

In connection with the areal mapping of the geology of the above-mentioned quadrangles, studies of the extent and quality of the peat in the region have been made by C. A. Davis, who, by the courtesy of the Bureau of Mines, was transferred to the Survey for a short time for the purpose of examining peat bogs along portions of the southern New England coast. These examinations promise to afford most interesting evidence of changes of level of the land now in progress in these regions.

Pending the publication of the Eastport folio a short paper on the geology of the Eastport quadrangle, also surveyed in cooperation with the State, was prepared by E. S. Bastin for submission to the State Commission. The fossils of the Silurian formations of this quadrangle are described in a paper now being prepared by H. S. Williams.

A reconnaissance examination of the geology of the Boothbay quadrangle and an inspection of the mapping of the Portland and Casco Bay quadrangles have been made by Arthur Keith.

#### MARYLAND.

Manuscript maps and folio descriptions of the Tolchester quadrangle, Md., surveyed in cooperation with the State Geological Survey, have been submitted for publication by B. L. Miller, and the areal mapping and study of the Coastal Plain in the Elkton and Wilmington quadrangles, also carried on under cooperation, have been completed by Mr. Miller, assisted by M. I. Goldman. The folio manuscript for these quadrangles is well advanced.

The gneisses of the Havre de Grace and Elkton quadrangles have been studied by Florence Bascom, who has nearly completed the maps and descriptions of the gneisses and similar rocks of the Elkton and Wilmington quadrangles for folio publication.

The fossil floras of the Upper Cretaceous formations of Maryland have been described in detail by E. W. Berry, and the fossil faunas and the character of the sediments are under investigation by Julia Gardner and M. I. Goldman.

The detailed study of the Carboniferous rocks of the Frostburg and Flintstone quadrangles has been nearly completed by C. K. Swartz, of the cooperating State Geological Survey, and the maps and descriptions of the remaining formations in the quadrangles have been completed by G. W. Stose for folio publication.

#### MASSACHUSETTS.

Substantial progress in the description of the complicated geology of the Boston and Boston Bay quadrangles, Mass., for the Boston folio, has been made by Laurence La Forge, who is engaged in the survey of the Framingham quadrangle, in order to include the results in the same folio. The Pleistocene deposits of these quadrangles were inspected by W. C. Alden early in November.

The geology of portions of the Becket quadrangle, in the western part of the State, has been reexamined by B. K. Emerson, who has submitted for publication, in joint authorship with T. N. Dale, the maps and text for a folio covering the Pittsfield and Becket quadrangles.

Folios covering the Belchertown, Barre, Palmer, and Brookfield quadrangles, of central Massachusetts, are now in preparation by Prof. Emerson. The eastern half of the Sheffield quadrangle has been mapped and described by Joseph Barrell in form available for later use in a folio.

Reconnaissance examinations were made by Arthur Keith in the Dedham, Salem, Andover, and Framingham quadrangles and special studies of the peat bogs in portions of the Boston and Framingham quadrangles have been carried on by C. A. Davis.

#### MICHIGAN.

The manuscript maps and descriptions for a folio on the Detroit quadrangle, Mich., prepared in cooperation with the State Geological Survey, have been completed and submitted for publication by W. H. Sherzer.

The results of recent exploration in the iron ranges have been assembled and compiled under the direction of C. R. Van Hise.



## MINNESOTA.

The field investigations necessary for the completion of the folio to cover the Herman and Barrett quadrangles, Minn., were carried out by F. W. Sardeson.

The collection of statistics and information regarding developments in the Lake Superior iron districts was continued under the direction of C. R. Van Hise.

Under a cooperative agreement entered into with the State Geological Survey in the autumn of 1912, the mapping of the Pleistocene deposits in the northern part of the State was begun by Frank Leverett, the study of the clays of the State was undertaken by F. F. Grout, and an investigation of the other building materials was begun by Oliver Bowles and A. W. Johnston.

## MISSISSIPPI.

The Pleistocene deposits and terraces in the region of Mississippi River have been studied by E. W. Shaw for the purpose of working out the Quaternary history of the region and of correlating the Quaternary features of the lower Mississippi Valley with the glacial and other Quaternary deposits of the upper part of the valley.

The marine invertebrate fossils of the Midway and associated formations in Mississippi are being investigated by C. W. Cooke for use in correlation with the formations in other parts of the Coastal Plain.

A report on the lower Oligocene floras of this State, Louisiana, and Texas has been submitted by E. W. Berry.

## MISSOURI.

After the publication by the Missouri Bureau of Geology and Mines of a general report by Henry Hinds on a reconnaissance economic examination of the coal fields of Missouri, made in cooperation with the State, the Queen City, Green City, and Smithville (formerly Mecca) quadrangles were cooperatively mapped in detail by F. C. Greene and M. Albertson, of the State bureau, under the supervision of Mr. Hinds. A brief economic report on the Novinger and Mendota coal fields, parts of which are included in the Green City and Queen City quadrangles, was prepared, through the courtesy of the State geologist, by Mr. Greene for publication by the Federal Survey.

During the winter and spring Messrs. Hinds and Greene were engaged in preparing a report upon the stratigraphy of the Pennsylvanian formations of the State, to be published by the Missouri Bureau of Geology and Mines, and material for the Leavenworth-Smithville and Green City-Queen City folios. Points of critical



interest in the Pleistocene deposits of these quadrangles were examined by the authors in conference with E. W. Shaw.

A report upon the genesis of the lead and zinc ores of the Joplin district has been completed by C. E. Siebenthal. The discussion of the origin of these ores has been reviewed after a study of the ores in the Wyandotte quadrangle in Oklahoma, and is contributory to the completion of the folio and economic report on that quadrangle. The delay in work on this folio is due to large demands on Mr. Siebenthal's time for preparation of reports on the production of lead, zinc, and cadmium for publication as advance chapters of Mineral Resources.

In company with the representatives of the State, the stratigraphy and correlations of the older Paleozoic formations in the Ozark region were briefly examined by E. O. Ulrich, assisted by R. D. Mesler. The faunas of the Boone limestone (Mississippian) were also considered.

The Pleistocene formations of the southeastern part of the State were examined in a reconnaissance by E. W. Shaw in order to trace them southward for correlation with the deposits of the Mississippi embayment.

#### MONTANA.

The survey of the Blackfeet Indian Reservation, begun in 1911 by M. R. Campbell and Eugene Stebinger, was continued in 1912 by Mr. Stebinger, who completed the mapping of those parts of the Cutbank, Blackfeet, and Browning quadrangles lying within the reservation, 702 square miles being examined in detail and 400 square miles in careful reconnaissance. Portions of the area were reviewed for paleontologic correlation by T. W. Stanton. A rapid reconnaissance was made by Mr. Stebinger over about 500 square miles in Tps. 32 to 35 N., Rs. 4 to 8 E. Work in this Indian reservation was done under the joint auspices of the section of western fuels and the section of western areal geology, only a part of the region being coal-bearing. The land was classified and a report on the low-grade iron ores of the reservation has been submitted for publication (in Bulletin 540-H), while another report on the general geology of the region is in preparation. The Pleistocene geology of the area was studied by W. C. Alden, who spent a short time in the field with Mr. Stebinger.

In connection with this work a reconnaissance trip was made by Mr. Alden and Mr. Stebinger in southern Alberta northward to and including the valley of Oldman River and to Lethbridge on Belly River. On this trip they obtained important information concerning the pre-Wisconsin glacial drift in the region of Glacier National Park and its relations to the Albertan drift of Dawson and McDon-

ald. A paper on this subject was submitted by Messrs. Alden and Stebinger for publication in the Bulletin of the Geological Society of America.

An examination of the Plentywood lignite field north of the Fort Peck Indian Reservation, in Valley County, was made by C. M. Bauer, work being limited to several townships which had been surveyed by the General Land Office. For the territory, including 302 square miles examined in reconnaissance, Mr. Bauer submitted data for classification and a geologic report for publication (in Bulletin 540-K).

The Tullock Creek coal field, which lies just east of the junction of Yellowstone and Bighorn rivers, was examined by G. S. Rogers, assisted by H. M. Robinson, and Mr. Rogers made a reconnaissance survey of the country traversed from Sheridan, Wyo., to the field of operations. The area examined in detail consists in part of what are known as the ceded lands of the Crow Reservation, which were surveyed at the request of the Office of Indian Affairs. The territory examined embraces 450 square miles surveyed in detail and 123 square miles surveyed in reconnaissance, the land being so classified that it could be sold at auction in September. Subsequently a geologic report on the region was submitted by Mr. Rogers for publication.

In order to obtain information regarding the geologic structure and the formations exposed in the region between Musselshell and Judith, at the mouth of Judith River, a reconnaissance, embracing an accurate planetable survey covering an area of about 1,410 square miles, was made by C. F. Bowen, assisted by H. S. Bassler, the geologic boundaries being tied to public-land corners. The reconnaissance established the presence of a small coal field east of Judith. Part of this area was classified by Mr. Bowen, who prepared for publication a report describing the important geologic features of the region, though there was not sufficient time in the field to complete the examination in detail.

In Chouteau County an area of 350 square miles, including the Big Sandy coal field, near Big Sandy, on the west side of the Bearpaw Mountains, was geologically mapped in detail by Mr. Bowen, assisted by Mr. Bassler, and Mr. Bowen has classified the lands in this field and prepared a geologic report for publication.

A brief examination of the Broadview coal field was made by E. G. Woodruff for the purpose of determining whether the land should be classified as coal or noncoal. Sufficient data were procured for the classification of the land, but no geologic report is contemplated, the general geology having been described in reports published by the Survey.

In Blaine County, the Cleveland coal field, embracing 423 square miles between the Bearpaw Mountains and the Fort Belknap Indian Reservation, was examined by Mr. Bowen, assisted by Mr. Bassler. The land has been classified by Mr. Bowen, who has also prepared a geologic report thereon for publication.

The Taff quadrangle, a portion of which lies in Idaho, was surveyed for folio publication by F. C. Calkins and E. L. Jones, jr., and the text of the Philipsburg folio has been revised and submitted for publication by Mr. Calkins.

Some progress in the metallographic study of the Butte copper ores has been made by F. B. Laney in the intervals between other studies. It is expected that the metallographic investigations of these and other ores will be more vigorously prosecuted jointly by the Geological Survey and the Bureau of Mines.

Two townships near Missoula were examined at the request of the Department of Justice by J. T. Pardee in connection with the case of the United States *v.* A. B. Hammond.

At the request of the Office of Indian Affairs, the classification of the lands in the former Flathead Indian Reservation was undertaken, about 1,300 square miles, or three-fourths of the reservation, being examined and reported on by R. W. Stone. In addition to his work in collecting mineral statistics for the reports on the gypsum, lime, and sand industries for the division of mineral resources, and in completing and editing the manuscript of a bulletin on the occurrence of useful minerals in the United States, Mr. Stone also prosecuted an inquiry regarding the water supply of the Pablo division of the Flathead Reservation reclamation project.

Four townships in the vicinity of Melrose were examined in detail by R. W. Richards in connection with his classification of the lands with reference to the possible occurrence of workable phosphate deposits. Classification reports covering this area have been transmitted by Mr. Richards.

The Northern Pacific Railroad grant, comprising all the odd-numbered sections in T. 5 N., R. 2 W., was examined for purposes of classification and reported on by J. T. Pardee.

#### NEBRASKA.

Late in the field season of 1912 a brief reconnaissance examination of the sand-hill area in northwestern Nebraska was made by J. H. Hance for the purpose of examining evaporation areas that might possibly be favorable for the deposition of potash in commercial quantities. The results of the explorations have been briefly reported by Mr. Hance.

## NEVADA.

Reconnaissance examinations of a large number of the lesser mining districts of Nevada and adjacent parts of northern California have been made by J. M. Hill, who has submitted for publication in "Contributions to economic geology, 1912, Part I" a short paper entitled "The Yellow Pine mining district, Clark County, Nev." (Bulletin 540-F); also a bulletin on "Some mining districts in northeastern California and northwestern Nevada" and a note on "Zinc-lead ore dressing at Good Springs, Nev.," for publication in Mineral Resources.

The geology and mineral resources of the Ely quadrangle have been made the subject of a monographic report by A. C. Spencer, which will probably be completed at an early date.

A report on the National district by Waldemar Lindgren is now nearly ready to submit for publication.

A paper on a newly recognized occurrence of alunite at Bovard has been prepared by F. C. Schrader for publication in Bulletin 540-I.

A reconnaissance examination of the Rochester, Fairview, Rawhide, and neighboring mining districts was made in May and June by F. C. Schrader, and a press bulletin on the Rochester district was issued in June.

In the course of the examination of the old lake basins for the purpose of discovering possible occurrences of potash in commercial quantities, visits were made by H. S. Gale to the alkali marshes near Rawhide, Luning, Minor, Rhodes, Teels Marsh, Columbus Marsh, the valleys north and south of Goldfield, and the valley of Amargosa River south of Rawhide. The Carson Sink was examined in connection with the deep drilling in that basin. Boring operations near Fallon were carried on under the immediate supervision of J. H. Hance. The deepest boring penetrated to a depth of 985 feet. Artesian flows of fresh or slightly saline waters were obtained at various depths, but no concentrated deposits of salines were found. Funds for deeper boring, which is very expensive, were not available at the time, and the test can not be regarded as conclusive.

Prospecting for buried saline deposits with a lighter boring equipment was continued throughout most of the year by a party in charge of C. E. Watson as driller. Wells were bored in the playa of Luning, Minor, Rhodes, Columbus Marsh, and Death Valley, and the samples were submitted to the chemical laboratory in Washington for testing.

Late in the season Mr. Hance made reconnaissance trips into Dixie Valley and portions of New Mexico and Arizona. A short report by him, entitled "Potash in western saline deposits," was submitted for

publication in "Contributions to economic geology, 1912, Part I" (Bulletin 540-P).

The Coaldale coal field, lying mainly in T. 2 N., R. 37 E., Esmeralda County, was examined and classified by J. H. Hance, who submitted a short report thereon for publication (Bulletin 531-K).

#### NEW HAMPSHIRE.

The examinations of the geology in the Milford and Petersboro quadrangles, N. H., have been continued by B. K. Emerson in connection with his work in the border areas of Massachusetts.

A portion of the final report embodying the results of the investigations made by the Survey with reference to the acquisition by the Government of lands in the White Mountains, in order to protect the headwaters of navigable streams, has been prepared by A. C. Spencer.

#### NEW JERSEY.

In order to inspect some recent developments in the zinc mines at Franklin Furnace, N. J., a brief visit was paid to this mine in May, on invitation from the State geologist, by F. L. Ransome and A. C. Spencer.

Inspection of the Easton quadrangle, geologically mapped by H. B. Kümmel and W. S. Bayley, was made in conference by Arthur Keith.

#### NEW MEXICO.

In response to a request from the Office of Indian Affairs that the Geological Survey examine and classify as coal or noncoal the lands in the Zuni Indian Reservation, D. E. Winchester, assisted by C. A. Bonine, examined in detail the entire reservation, embracing an area of 415 square miles. The preparation of a geologic report is deferred, in the hope that additional field work may be done in order to prepare a folio based on a 30-minute quadrangle.

A detailed examination of a small area of coal land near the town of White Oaks, known as the White Oaks coal field, and a reconnaissance of a larger coal-bearing area adjacent to the Sierra Blanca were carried out by C. H. Wegemann, who classified the lands and submitted a brief geologic report covering the areas.

Some of the results of the studies of coal-bearing formations of southern Colorado and northeastern New Mexico, by W. T. Lee, are included in the stratigraphic part of a report on the Raton Mesa region of Colorado and New Mexico. This report, which contains also descriptions of the very interesting fossil floras of the same region, by F. H. Knowlton, has been submitted for publication as a bulletin of the Survey. In connection with the field

work in this area a reconnaissance section was traversed by Mr. Lee and T. W. Stanton, from Albuquerque to Lumberton, via Rio Puerco, Cabezón, and Cuba, for the purpose of studying the Cretaceous and Tertiary stratigraphy.

The geology of the vicinity of Dayton, where drilling for petroleum is in progress, was preliminarily examined in March by G. B. Richardson, who has submitted a short paper on petroleum near Dayton (in Bulletin 541-D).

The geologic work by Sidney Paige in the Silver City quadrangle, and by N. H. Darton in the Deming quadrangle, was inspected by F. L. Ransome, and the folio manuscripts for these quadrangles are now practically completed.

#### NEW YORK.

The Niagara quadrangle and the environing region in the western part of New York has been further examined by F. B. Taylor, who has completed the description and mapping of the surficial formations for use in the Niagara folio (No. 190). Some additional consideration in the field has been given by E. M. Kindle, joint author of the folio, to the characters and correlations of the Paleozoic formations in the quadrangle. Mr. Taylor also made reconnaissance examinations of the surficial formations in portions of the Taconic and Hoosatic areas in eastern New York and western Massachusetts.

The areal and stratigraphic geology of the Hoosick quadrangle, situated on the Vermont boundary, has been examined by L. M. Prindle, for description, together with the Bennington quadrangle, Vermont, in a folio.

The slate quarries of the State have been reexamined in connection with the revision by T. N. Dale of Bulletin 275, on the slate industry of the United States, which is now out of print.

Prior to his resignation from the Survey, July 31, to join the Geological Survey of Canada, Mr. Kindle was engaged in preparing papers on the faunas and stratigraphy of the Allegheny region and on the Onondaga limestone in the State.

Special studies of the relations of the Medina and associated formations in New York and other Appalachian States have been made by E. O. Ulrich for purposes of correlation and chronologic classification.

#### NORTH CAROLINA.

The folios for the Lincolnton quadrangle, in North Carolina, and for the Kings Mountain and Gaffney quadrangles in North and South Carolina, have been well advanced toward completion by D. B. Sterrett. A considerable portion of Mr. Sterrett's time is, however, consumed in preparing reports on the production of mica, gems, and precious stones for Mineral Resources.



Arthur Keith made further studies of peculiar metamorphic rocks that occur near Murphy, N. C., and around Ducktown, Tenn., and presented a brief paper on these rocks at the meeting of the Geological Society of America.

A monographic study of the Cretaceous mollusks of the State was begun by L. W. Stephenson. Additional work on fossils from North Carolina has been carried on by W. B. Clarke and other members of the Maryland Geological Survey.

A report on the Coastal Plain of North Carolina, prepared cooperatively, has been published by the State Geological Survey. This report contains a paper on the physiography and geology of the central plain region, prepared by W. B. Clarke, B. L. Miller, and L. W. Stephenson, and a description of the water resources of the State by Mr. Stephenson, B. L. Johnson, and H. N. Parker.

#### NORTH DAKOTA.

The detailed examination of the northern part of the Fort Berthold Indian Reservation made in previous years for the purpose of determining whether or not the land is underlain by lignite was continued southward by C. M. Bauer, assisted by C. A. Fath, but on account of the lateness of the date at which it was possible to begin the work the survey was carried only as far south as Little Missouri River, including an area of 208 square miles. Data for the classification of this land have been submitted by Mr. Bauer, who has prepared for publication a report covering not only the area surveyed in 1912, but that previously examined by F. A. Herald. Field operations with the intention of completing the unsurveyed portion of the reservation lying south of Little Missouri River were resumed in June by Mr. Bauer, assisted by C. A. Bonine.

The examination of the Cannonball River lignite field was extended from the west line of Perkins County, S. Dak., northeastward into North Dakota by E. R. Lloyd, for the purpose of delimiting on the southeast side the great lignite field of this region. From the area examined in detail by Mr. Lloyd, assisted by B. W. Cark, embracing 980 square miles, sufficient data to classify the land were obtained and also a remarkable collection of marine fossils in beds that in this region have heretofore been called the Lance formation. It is probable that these fossils will throw considerable light on the relations and age of the Lance and Laramie formations. Besides submitting this data for classification of the land, Mr. Lloyd has prepared for publication a paper describing the geology and economic resources of the region.

The survey of what is called the Bowman County lignite field, begun by C. J. Hares in 1911, in Billings County, was in 1912 continued southward by Mr. Hares, with the assistance of E. M. Parks



and J. B. Reeside, jr., into Bowman County and on south into South Dakota, an area of 753 square miles being covered in careful reconnaissance. Complete classification data were obtained and have been submitted by Mr. Hares, together with a geologic report covering the area surveyed in 1911 and 1912.

## OHIO.

The areal and stratigraphic survey of the Mason and Hamilton quadrangles, Ohio, was begun in June by R. S. Bassler, temporarily transferred for this work from the National Museum, and N. M. Fenneman, who, after revising the Pleistocene geology of the Cincinnati quadrangles, began the study of the Pleistocene formations and the economic geology of the Mason and Hamilton quadrangles, Mr. Bassler being responsible for the description of the Paleozoic formations. The results of the work will be put in folio form by these geologists.

The survey in detail of the structural and areal geology of the Steubenville and Cadiz quadrangles was completed by D. D. Condit, who, in connection with the revision of the earlier map showing the underground structure, submitted for publication in "Contributions to economic geology, 1912, Part II," a report on the structure and oil resources of the northern half of the Cadiz quadrangle (in Bulletin 541-A). The preparation of a folio by Mr. Condit covering these quadrangles is now in progress.

A brief reconnaissance examination of the stratigraphy in a portion of the Wellsville quadrangle was made by Mr. Condit and G. S. Rogers in the latter part of June.

The manuscript maps and descriptions for the Cleveland folio, covering the Cleveland, Euclid, and Berea quadrangles, have been discussed in the field by H. B. Cushing, the generous contributor of the geologic work, and E. M. Kindle.

The records of two deep wells penetrating the pre-Cambrian crystalline rocks near Findlay have been compiled and correlated by Mr. Condit in a short paper printed in the American Journal of Science, accompanied by a paper reporting the rock temperatures at various depths in one of the wells, as observed by John Johnston, who, through the courtesy of the Carnegie Geophysical Laboratory, has cooperated with the Survey in determining the temperatures in several deep wells in the Appalachian oil fields. The purpose of the investigations thus begun is not only to ascertain the rate of downward increase of temperature in rocks of various kinds and in different parts of the country, but also to determine whether, as is believed by some geologists, the increase of temperature is more rapid in rocks containing petroleum and natural gas.

## OKLAHOMA.

Detailed study of the geology of the Hominy quadrangle, Okla., was begun and nearly two-thirds completed by R. H. Wood, assisted by J. E. Gaughan, of the State survey, with which the work was done in cooperation. At the close of the season's work a special examination of the structure and conditions of occurrences of oil in the Cleveland field was made by Mr. Wood. A report giving the results of this work, which was not cooperative, is in preparation.

Maps and descriptions of the areal geology and structure of the Claremore quadrangle, by C. D. Smith, are now nearly ready to submit for publication, but await adjustment with work on the Nowata and Vinita quadrangles that is nearly completed but is still in the hands of D. W. Ohern, State geologist. A bulletin on the oil and gas resources of northeastern Oklahoma has been nearly completed by Mr. Ohern and Mr. Smith.

On account of the interest of many residents of Cotton and Tillman counties, southwestern Oklahoma, in the possible occurrence of oil or natural gas in that region, a reconnaissance examination of this geologically little-known area was, at the request of the State geologist, cooperatively undertaken by the Federal Survey. During the autumn and early winter a large area in these counties bordering Red River was examined by M. J. Munn, with the assistance of Jeremiah Newby. The task of determining the structure of this area proved to be exceedingly difficult, but geologic structure offering encouragement for "wildcat" prospecting was found by Mr. Munn in a portion of the area. A report with maps embodying the results of this examination has just been submitted by Mr. Munn for publication as a bulletin.

A brief description of the Ponca City oil field, by D. W. Ohern, published as a bulletin of the Oklahoma Geological Survey, is based in part on work by C. D. Smith and R. H. Wood, of the Federal Survey.

The investigation of the zinc and lead deposits of northeastern Oklahoma and adjacent parts of Missouri has been continued by C. E. Siebenthal, who will embody the results in the Wyandotte folio, now nearing completion.

Additional field work necessary to complete the mapping and to prepare folios for the San Bois and Sallisaw quadrangles, nearly finished several years ago by J. A. Taff prior to his resignation, was done by C. D. Smith, who also submitted short reports on the Glenn pool and on the Fort Smith-Poteau oil and gas pools for publication in "Contributions to economic geology, 1912, Part II" (Bulletin 541-B).

At the request of the Commissioner of Indian Affairs a small area in McCurtain County, in the southeastern part of the State, was examined by D. F. Hewett with reference to the value of the manganese deposits of the district.

In March an examination of certain alleged gold deposits in the vicinity of Albion, Pushmataha County, was made by the Survey at the request of the Office of Indian Affairs. The report by H. G. Ferguson, who found the claims of rich ores in commercial quantities to be unwarranted, was transmitted to the Secretary of the Interior in April.

## OREGON.

A brief reconnaissance examination of the Eden Ridge coal field, Coos County, Oreg., was made by M. R. Campbell in order to determine whether or not the coal is of sufficiently high grade to justify the classification of the land as coal land. For this purpose many samples of the coal were taken for analysis and detailed measurements of the beds were made.

In June a reconnaissance examination of the John Day Valley, mainly with the object of investigating reported indications of coal and oil, was, in accordance with a cooperative agreement with the new State bureau of mines and geology, begun by a party in charge of A. J. Collier.

## PENNSYLVANIA.

A detailed areal survey, by B. L. Miller, of the geology of the Allentown quadrangle, Pennsylvania, has been nearly completed, and the results will be included in a folio covering also the Easton quadrangle, surveyed by H. B. Kümmel, State geologist of New Jersey, and W. S. Bayley.

Geologic maps covering the Fairfield and Gettysburg quadrangles have been prepared by G. W. Stose, and the map and description of the Bellefonte quadrangle have been revised by E. S. Moore.

A special investigation of the gneisses of the Coatesville and Westchester quadrangles was made by Florence Bascom, and a study of the gneisses in the Boyertown quadrangle was practically completed under the direction of Prof. Bascom, who also supervised the mapping of about three-fourths of the Reading quadrangle by E. T. Wherry.

Progress has been made on the Honeybrook-Phoenixville folio.

A paper on the relations of the Octoraro schist to the Wissahickon mica gneiss in the Coatesville quadrangle, prepared by E. F. Bliss and A. I. Jonas, working under the supervision of Prof. Bascom, has been submitted for publication as a bulletin.

A narrow strip in the northern portion of the Frostburg and Flintstone quadrangles, which falls in Pennsylvania, has been examined and described by G. W. Stose and C. K. Swartz for publication in the Frostburg-Flintstone folio, the project being carried out in cooperation with the Maryland Geological Survey.

Substantial progress has been made in the preparation of folio texts to cover the Punxsutawney, Curwensville, and Houtzdale quadrangles, the greater part of the field work for which was done several years ago by G. H. Ashley and others in cooperation with the State topographic and geologic survey commission. A short paper describing the geologic structure of these quadrangles, together with that of the Barnesboro and Patton quadrangles, also surveyed cooperatively, was prepared by Mr. Ashley and M. R. Campbell and published in "Contributions to economic geology, 1911, Part II" (Bulletin 531-D). Subsequently the Barnesboro-Patton folio was submitted for publication.

To gain information as to the regional changes in the composition of the coals in a single field, the northeastern borders of the bituminous coal region were visited and the coal sampled by M. A. Pishel in May.

For the purpose of obtaining data as to underground temperatures in very deep borings, the well over 6,000 feet in depth now being bored by the People's Natural Gas Co., near Candor, in Washington County, was visited and the temperature at various depths determined by John Johnston, of the Carnegie Geophysical Laboratory, in cooperation with the United States Geological Survey, in accordance with a plan by which the temperatures of several deep wells in other States have been determined.

The slate quarries of the State have been newly described by T. N. Dale in the revised bulletin on the slate industry of the United States.

#### SOUTH CAROLINA.

Folios descriptive of the geology of the Kings Mountain and Gaffney quadrangles in North and South Carolina have been brought nearly to completion by D. B. Sterrett. The work in the Gaffney quadrangle was inspected by Mr. Keith.

A report on the deep well at Charleston, S. C., has been nearly completed by L. W. Stephenson, but awaits the results of the studies of the rich foraminiferal material, by J. A. Cushman, and a report by Chase Palmer on the analyses of the water and comparisons with related underground waters of the region.

In view of projected drilling for oil or gas in Abbeville and Greenwood counties, a brief visit to the region was paid in June by F. L. Hess, who demonstrated the futility of boring for these hydrocarbons in the crystalline and ancient metamorphic rocks of the region.

## SOUTH DAKOTA.

The areal mapping of the Spearfish and Sturgis quadrangles, which form the northern half of the Deadwood 30-minute quadrangle, S. Dak., was completed by Sidney Paige, associated with N. H. Darton and assisted by Y. T. Wang. A part of the southern half of the Deadwood quadrangle also was surveyed. The mapping of the Cambrian and later formations in the Rapid quadrangle, the maps and text for which are to be combined with those for the Deadwood quadrangle in the same folio, had previously been completed by Mr. Darton. A petrographic study of the pre-Cambrian rocks of the Black Hills has been made by Mr. Paige, who has prepared several papers, including one on the structure of the Homestake ore body, for publication in scientific journals.

The work of mapping the lignite field in the northwest corner of the State was begun in 1911 by D. E. Winchester and E. M. Parks, who had time only to examine the margin without completing work in the interior. In 1912 the remainder of the area was surveyed by E. R. Lloyd and C. J. Hares, who covered, respectively, areas of 520 and 522 square miles, thus completing field work on the only known lignite field in the State. Data for classification and a geologic report for publication have been submitted. A consolidation by Mr. Winchester of the reports of the work done in 1911 and 1912 has been submitted for publication as a bulletin of the Survey.

## TENNESSEE.

A report giving the results of the examinations of the red iron-ore deposits of east Tennessee by E. F. Burchard has been submitted for publication to the Geological Survey of Tennessee, with which the work was done in cooperation. A shorter report has been prepared for publication in "Contributions to economic geology, 1912, Part I" (Bulletin 540-G).

An extensive field study of the rocks of Medina and Clinton age in east Tennessee has been made by E. O. Ulrich, who has in preparation a report on the stratigraphy and faunas of the formations, with special reference to the geologic classification of the ore-bearing formations and the Ordovician-Silurian boundary.

Collections of the Tertiary plants of Tennessee and western Kentucky were made in June by E. W. Berry for comparison and correlation of the plant beds with the Tertiary formations in other regions.

In the region near the Mississippi in Tennessee and western Kentucky the Pleistocene deposits and terraces were investigated by E. W. Shaw, six cross profiles of the Gulf embayment were compiled, and material was collected for use in the study of the problems

of Quaternary deposition and history in the region. The work promises to be of value in connection with the solution of the flood problems of the lower Mississippi.

The survey of the areal geology of the Ducktown district has been revised by F. B. Laney, who has the descriptions well advanced. The completion of this work was delayed by examinations made for a report on lands in the proposed southern Appalachian national forests and for the Department of Justice. The descriptions of the Ducktown ore deposits are in preparation by W. H. Emmons.

A paper describing the peculiar metamorphic rocks around Ducktown was presented by Mr. Keith at the winter meeting of the Geological Society of America.

Some additional work in the preparation of an economic report on the coal measures of the Pikeville and Crossville 15-minute quadrangles has been done by Charles Butts and W. C. Phalen, but the submittal of the report for publication awaits the determination of the stratigraphic equivalents of the rocks at several points in the quadrangles. The preparation of folio texts for these quadrangles is delayed until the adjoining quadrangles are surveyed for description in double folios.

The recent developments of bauxite deposits in Tennessee were examined by W. C. Phalen for description in the report on the production of bauxite for Mineral Resources.

#### TEXAS.

The geology of the Van Horn quadrangle, Tex., for which a folio is now ready for publication, was inspected by G. B. Richardson, the author, and F. L. Ransome.

The manuscript for the folio covering the Brackett quadrangle has been nearly completed by T. W. Vaughan, who, besides supervising the work of others and inspecting it in the field, has made progress on several reports of general or special scientific interest pertaining to all parts of the Coastal Plain.

The study of the Tertiary and Pleistocene formations of southwestern Texas has been continued by Alexander Deussen. This work comprised the examination of the lithology and stratigraphy of the entire series of Tertiary formations developed in the region adjacent to the Rio Grande from a point near the northern line of Maverick County southward to Samfordyce. A rapid reconnaissance was carried over an area of more than 10,000 square miles, within which collections were made of fossils, specimens of rocks, and water samples for analysis. Under Mr. Deussen's direction samples of water were taken from 200 wells and other data were obtained for about 350 wells in Bexar, Medina, Uvalde, Kinney, Maverick, Zavalla, Dimmit, Webb, Frio, La Salle, Atascosa, McMullen, Duval, Brooks, Starr, Hidalgo, Cameron, Willacy, Jim Wells, and Nueces counties.



The fossil floras of the Midway and Wilcox formations have been described and figured in a manuscript submitted by E. W. Berry. These floras are important for their value in establishing correlations between the marine Coastal Plain sections and the coal-bearing formations of the northern Rocky Mountain province.

The structure of a small area in Texas bordering the Shreveport-Caddo district of Louisiana was examined in detail with reference to oil and gas by G. C. Matson, who is preparing a report on that district, with structure maps.

A report on the geology and underground water resources of the central part of the Coastal Plain of Texas, by Mr. Deussen, is approaching completion. By direct collection and by correspondence 403 water samples were obtained from southwest Texas and analyzed. Of the analyses 190 have been transmitted to R. B. Dole, chemist of the water resources branch, for use in a report on the chemical characters of the waters.

The geology and hydrology of the region between Atascosa and Nueces rivers and a line drawn through Uvalde, Cotulla, Hebbronville, and Katherine have been examined by Mr. Deussen, who has also investigated, at the request of the War Department, the underground water prospects in the Leon Springs Military Reservation in Bexar County and at the old target range near Fort Sam Houston.

Supplementary studies were made by L. W. Stephenson of the structural relations of the Upper Cretaceous deposits exposed at several places in northeastern Texas and southwestern Arkansas and in portions of southwestern Texas, where detailed studies of the stratigraphy, structure, and paleontology of the Upper Cretaceous rocks were made in connection with Mr. Vaughan's work in the Brackett quadrangle.

Through the courtesy of J. A. Udden and the Bureau of Economic Geology and Technology of the State a set of field notes and maps, prepared by Mr. Udden and containing valuable geologic data relating to portions of Maverick, Dimmit, Zavalla, Uvalde, Kinney, and Valverde counties, were placed at the disposal of Messrs. Vaughan and Stephenson.

A brief examination of the geology and structure in the vicinity of Electra was made by M. J. Munn and David White. A close watch for structures favorable for oil and gas was maintained by G. C. Matson in connection with his field work in Coastal Plain investigations.

#### UTAH.

The completion of the report on the geology and ore deposits of the Tintic district, Utah, has been somewhat delayed by the departure of the senior author, Waldemar Lindgren, in November, to take



charge of the department of economic geology in the Massachusetts Institute of Technology, but Mr. Lindgren will devote a part of his time to Survey work and it is expected that the report will be submitted at an early date. A portion of the report, by G. F. Loughlin, junior author, has been completed.

During the field season Mr. Loughlin made reconnaissance surveys of several mining districts in Utah. He visited the Erickson, Desert Mountain, Columbia, West Tintic, North Tintic, Tintic, Bingham, Cottonwood, American Fork, Provo, Santaquin, Mount Nebo, and Sierra Madre districts, for all of which, except the last, he prepared chapters for inclusion in a general report on the geology and ore deposits of Utah, which he is writing in collaboration with B. S. Butler. Field work for these studies will be completed in 1913.

A paper entitled "A reconnaissance in the southern Wasatch Mountains" was contributed by Mr. Loughlin to the *Journal of Geology*.

A reconnaissance examination of the Ophir, Mercur, Little Cottonwood, and Bingham mining camps was made by B. S. Butler for use in a report on the ore deposits of Utah now in preparation. Professional Paper 80, "Geology and ore deposits of the San Francisco and adjacent districts, Utah," by Mr. Butler, was in press at the close of the year and has since been published.

The study of the detailed areal and structural geology of the Randolph quadrangle was completed by G. B. Richardson, assisted by P. V. Roundy, and a folio text on the area is now in course of preparation. A paper on the Paleozoic section in northern Utah was prepared by Mr. Richardson and published in one of the scientific journals.

The Carboniferous formations of the Randolph quadrangle and of several other areas in the State were paleontologically studied in the field by G. H. Girty, who was assisted in the office by Mr. Roundy.

A detailed geologic study begun in the Sunnyside quadrangle, Carbon County, by F. R. Clark in 1911 in cooperation with a topographic party, was carried westward in 1912 into the Wellington quadrangle, and though the work was seriously handicapped by unforeseeable circumstances, the coal beds were prospected and mapped within a territory covering 230 square miles, thus completing the survey of a considerable portion of the quadrangle.

The survey of the Emery coal field, Emery County, begun in 1911, was completed this year by C. T. Lupton. The mapped area includes about 215 square miles in the Emery coal field and in Salina Canyon, in the Wasatch Plateau, the examination of the latter area being made for the purpose of classifying the land. The land in the Emery coal field has also been classified by Mr. Lupton and a geologic report thereon submitted by him for publication.

Some indications of oil having been found in the region southeast of the town of Green River, in Grand County, and some drilling having been done in the hope of developing a commercial oil field, a detailed survey of the area, containing about 300 square miles, was made by Mr. Lupton, assisted by M. W. Ball. The examination afforded data adequate for the classification of the land and information as to the possibilities of obtaining oil in the field. A geologic report thereon has been submitted for publication by the Survey (in Bulletin 541-D).

A brief examination of the territory surrounding the Coalville coal field, previously mapped, was made by C. H. Wegemann in order to determine the relation of the coal-bearing rocks of the Bear River and Green River regions to the Uinta Mountain uplift, this information being required for incorporation in a folio to cover the Coalville quadrangle. A geologic report on the Coalville coal field has been completed and submitted by Mr. Wegemann for publication.

The salt industry on the shores of Great Salt Lake was examined by W. C. Phalen, who forwarded samples of the brines and bitterns and rock salts for examination in the Survey laboratory. A bulletin embodying the results of the study of the commercial saline deposits of the country is now in preparation by Mr. Phalen.

#### VERMONT.

The examination of the marble districts of the eastern half of Vermont has been completed by T. N. Dale, who has submitted the results for publication as a bulletin.

Special investigations of the stratigraphic succession and structure in the faulted area of the north end of the Taconic Mountains, in the Brandon and Castleman quadrangles, were carried on by Arthur Keith, who presented a paper on the subject at the winter meeting of the Geological Society of America. In connection with these studies a conference on the stratigraphy in the vicinity of Sudbury was held by Mr. Keith, Mr. Hale, G. W. Stose, and L. M. Prindle, to determine the relation of the Cambrian and Ordovician rocks.

In connection with the revision of the bulletin on the slate industry of the United States, which is now out of print, Mr. Dale has re-examined the slate quarries of this State.

The study of the areal and structural geology of the Hoosick and Bennington quadrangles, portions of which lie in Vermont, has been continued by L. M. Prindle.

#### VIRGINIA.

The detailed survey of the Abingdon quadrangle, in the southwestern part of Virginia, was continued, the work in the northern half being completed by G. W. Stose, who has prepared for publica-

tion by the State geological survey a report on the salt and gypsum deposits of the area. For purposes of geologic correlation, collections of fossils were made by T. E. Williard from several important horizons and localities in this region.

Studies of the paleontology and stratigraphy of the Tertiary formations in the Coastal Plain of the State are now being made by a number of geologists and paleontologists under the immediate direction of W. B. Clark, practical cooperation being maintained in this work with the members of the Geological Survey of Maryland. Portions of the areas examined were visited by T. W. Vaughan.

A cooperative report on the underground water resources of the Coastal Plain of Virginia, by Samuel Sanford, has been published by the Virginia Geological Survey.

A detailed areal and economic survey of the southwestern coal field was begun in cooperation with the State Geological Survey. During the season the coal measures of the Pound quadrangle were mapped by Charles Butts, assisted by D. D. Condit and by W. A. Nelson, representing the State. This work, which was done in conjunction with the topographic remapping of the region on a 15-minute scale, was carried on with a precision and detail that establish a new standard of Survey work in the eastern coal fields. A preliminary report on the coal resources of the Pound quadrangle has been prepared by Mr. Butts for publication. In June, 1913, work in the Clintwood quadrangle was taken up by Henry Hinds, with the assistance of J. H. Harnsberger for the State.

In connection with the remapping of the coal-bearing area mentioned above, the other geologic formations occurring in the quadrangles are being mapped in greater refinement. With this end in view, collections of fossils for paleontologic study and correlation were gathered by Mr. Butts and Mr. Williard from a number of sections of the Devonian and Mississippian in the vicinity of Bigstone Gap and Cumberland Gap. These collections are expected to prove of great value in the solution of certain problems concerning the stratigraphy and geologic history of the area. A paper on the Devonian black shale in Virginia was presented by Mr. Butts at the December meeting of the Geological Society of America.

#### WASHINGTON.

The field examinations for the classification of the lands in the diminished Colville Indian Reservation, Wash., were carried on from April 1 to October 11 by J. T. Pardee, who during this period, without scientific assistance, examined approximately 1,400 square miles in the eastern part of the reservation. Reports for the classification of 838,037 acres, approximately equivalent to 1,309 square miles, were prepared and submitted by Mr. Pardee prior to July 1.

Under the direction of Mr. Pardee, E. L. Jones, jr., examined lands in T. 40 N., Rs. 27, 28, 29, 30, 31, 34, and 40 E.; T. 38 N., R. 37 E.; and T. 37 N., R. 37 E., Willamette meridian, on request of the Secretary of the Interior and the Commissioner of Indian Affairs, for classification as mineral or nonmineral.

A special report on the status of certain mineral claims in conflict with power-site reserve 211, on Nespelem River, was during December prepared by Mr. Pardee for submission to the Secretary of the Interior.

At the request of the Office of Indian Affairs an examination of the Yakima Indian Reservation for the purpose of determining whether it is underlain by coal was made by M. A. Pishel, who found that the area contains no coal beds. Numerous data obtained by Mr. Pishel as to the underground water supply in this region have been incorporated in Water-Supply Paper 316.

A brief examination of the Glacier coal field, in Whatcom County, was made by E. G. Woodruff, who has submitted data for the classification of the land and a short geologic report for publication.

#### WEST VIRGINIA.

For the purpose of procuring data for the comparison of the coals of the lower Tug River district, in southern West Virginia, with those of eastern Kentucky and the northern Appalachian region, a set of coal samples was collected in this district by Eugene Stebinger for standard chemical analysis.

Observations of temperatures in a deep well in process of boring by the William Seymour Edwards Oil Co. on Slaughter Creek, in the southern part of the State, were early in the season made by John Johnston, of the Carnegie Geophysical Laboratory, in cooperation with which the work was done. Arrangements preliminary to the observations were made by Dr. I. C. White, State geologist.

Lands in the Monongahela basin were examined by A. C. Spencer, who rendered a report favoring their purchase under the act of Congress which provides for acquisition of lands to protect the headwaters of navigable streams.

#### WISCONSIN.

The manuscript on the Pleistocene and general geology of southeastern Wisconsin has been revised by its author, W. C. Alden, and an introduction to the report has been furnished by T. C. Chamberlin, under whose direction the studies therein described were carried on.

The results of continued exploration in the iron ranges have been collected and compiled under the direction of C. R. Van Hise.

## WYOMING.

The Douglas oil field, in Converse County, Wyo., was examined late in the season of 1912 by V. H. Barnett, who, though he surveyed only a small area (170 square miles), gathered sufficient data for the classification of the land and for a geologic report, which has been submitted for publication (in Bulletin 541-C).

The upper Belle Fourche Valley coal field, embracing an area of about 3,100 square miles, was examined in 1910-11 by Mr. Barnett, who during the present year has completed a full report on the geology and mineral resources of the field for publication as a bulletin of the Survey.

The increasing demand for more exact and immediate knowledge of the character of coals has made it necessary to provide the field geologist with some handy means of analysis. Accordingly, C. E. Lesher spent some time in Wyoming, North Dakota, Montana, and Colorado in testing a field apparatus devised to determine the ash and moisture content of coals. The experiments made by Mr. Lesher show that by means of a cheap, light outfit the geologist can determine the ash content of a coal within 1 or 2 per cent and can thus obtain in the field much needed information regarding the variability of the coals in the lands he examines and maps for classification.

An area of about 90 square miles in the Ilo quadrangle, Hot Springs County, was geologically surveyed by D. F. Hewett in association with a party making a topographic map of the area. The examination of the Oregon Basin and Meeteetse quadrangles, Park County, surveyed by Mr. Hewett with the Ilo quadrangle for folio publication, was undertaken to determine whether the many small structural domes and anticlines occurring in this part of the Bighorn Basin are favorable for the accumulation of oil and gas. A report covering this question is in preparation but not yet ready for publication. However, a short paper describing the geologic section exposed at Cody and discussing the relation of the structure at that place to the occurrence of oil in the vicinity has been submitted by Mr. Hewlett for publication (in Bulletin 541-C).

A brief examination of the Spring Valley oil field, in Uinta County, previously described by A. C. Veatch, was made by C. H. Wegemann for the purpose of noting recent developments. As these have not thrown any new light on the occurrence of the oil an additional report is not deemed necessary at the present time.

Field work for a detailed survey of the areal and economic geology of the Fort Steele and Hanna quadrangles, in Carbon County, was begun late in the season by A. L. Beekly, who devoted about a month to the work. After the resignation of Mr. Beekly, June 1, 1913, C. F. Bowen was placed in charge of this work, which was resumed June 15.

The stratigraphy of the Oregon Basin quadrangle was reviewed by T. W. Stanton in association with Mr. Hewett. Later Mr. Stanton, with Mr. Beekly, examined the stratigraphy in several sections of the Walcott quadrangle.

The Randolph quadrangle, lying partly in Utah, was examined by G. B. Richardson, assisted by P. V. Roundy, and the greater part of the office season was devoted to the preparation of maps and text for a folio.

The gold, silver, and copper bearing veins of the Kirwin district were examined in July by D. F. Hewett, who has submitted a brief report for publication in "Contributions to economic geology, 1912, Part I" (Bulletin 540-C).

#### CANAL ZONE.

Through a cooperative agreement between the Isthmian Canal Commission, the Smithsonian Institution, and the Geological Survey, geologic investigations of wide general interest, as well as economic importance, are being prosecuted in the Isthmian region. In this work the Survey undertakes to cut thin sections of rocks, to furnish rock analyses and petrologic data, and to provide paleontologic reports. A paleontologic knowledge of the formations in this region is of prime value in unraveling the geologic history of North America and is indispensable to the successful correlation of the geologic formations of the Atlantic coast of America with those of the Pacific coast.

The paleontologic studies, arranged by T. W. Vaughan, enlist without compensation the scientific service of a number of specialists not in the employ of the Government. By this arrangement M. A. Howe studies the calcareous algæ, E. W. Berry the fossil plants of higher orders, J. A. Cushman the Foraminifera, W. B. Clark the echinoids, R. S. Bassler the Bryozoa, M. J. Rathbun the Crustacea, J. W. Gidley the fossil vertebrates, W. H. Dall the fossil Mollusca, and T. W. Vaughan the corals. Mr. Howe has submitted a report on the algæ and Mr. Cushman has prepared a preliminary report on the Foraminifera.

An examination of certain structural and physical problems in geology, concerned in the canal construction, was early in the spring made by G. F. Becker. The results of these studies have been submitted to the Canal Commission.

The building stones and other rocks transmitted by the commission have been analyzed and petrologically determined by the Survey, engineering tests of the samples have been made by the Bureau of Standards, and analyses and calorimetric tests of coals have been furnished by the Bureau of Mines.



## HAWAIIAN ISLANDS.

A report on the lavas of the Hawaiian Islands was completed by Whitman Cross and will be submitted for publication during the coming year.

## DUTCH GUIANA.

In response to an application from the Department of Justice H. G. Ferguson was, early in October, detailed to proceed to Dutch Guiana in order to examine certain mining properties whose promoters had been charged with making improper use of the mails. The results of the examination were promptly transmitted to the Department, which instituted proceedings against the offenders.

## DIVISION OF ALASKAN MINERAL RESOURCES.

## CLASSES OF WORK.

In the last fiscal year the appropriation for the "continuation of investigation of the mineral resources of Alaska" was not made until August 24, 1912, and was reduced from \$100,000 to \$90,000. The general effect of this delay has been mentioned earlier in this report. Under this authority, as in previous years, work of the following classes was carried on: Reconnaissance and detailed geologic surveys, special investigations of mineral resources, reconnaissance and detailed topographic surveys, investigations of water resources with reference to the supply available for placer mining, and collection of statistics on mineral production.

## PERSONNEL.

The personnel of the division varied somewhat during the year on account of transfers of employees to and from other divisions and on account of temporary employment of technical assistants. On July 1, 1912, there were employed in the division 1 geologist in charge, 9 geologists, 4 topographers, 2 engineers, 3 clerks, and 1 draftsman on annual salaries, and 2 geologic field assistants. On June 30, 1913, the personnel of the division included 1 geologist in charge, 11 geologists, 4 topographers, 2 engineers, 1 draftsman, and 3 clerks on annual salaries, 2 geologic field assistants, and 31 camp hands and recorders. One geologist employed for nine months during the year and one employed for four months are not included in the above enumeration.

## FIELD OPERATIONS IN SEASON OF 1912.

*Allotments and areas covered.*—In spite of the late date of the passage of the appropriation act it was deemed best, in view of the large number of investigations for which there was urgent need, to



undertake certain pieces of work. It was, however, fully realized that this work would be very expensive, considering the results which could be achieved.

Twelve parties in all were engaged in surveys and investigations during 1912. Of these, two started in April, one in May, two about the first of July, and the others between the 10th and 29th of August. The average length of the Alaska field season in the past has been 110 days, but in 1912 it was only 53 days. Moreover, in 1912 the parties worked late into the fall, when much time was lost owing to rain and snow.

The areas covered by geologic reconnaissance surveys, on a scale of 1:250,000 (4 miles to the inch), amount to 2,000 square miles; those covered by detailed geologic surveys, on a scale of 1:62,500 (1 mile to the inch), to 525 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the important mining districts, the results of which can not be presented areally. No topographic reconnaissance surveys were made in 1912. Detailed topographic surveys, on a scale of 1:62,500 (1 mile to the inch), covered 298 square miles. Sixty-nine gaging stations were maintained in the Yukon-Tanana region in 1912 for an average of 14 weeks each, furnishing data on the water resources of the Fortymile, Eagle, Seventymile, Birch Creek, and Fairbanks districts. The following table shows the allotments of the appropriation to the different districts of Alaska. These figures include the cost of both field and office work, as well as inspection. The unallotted balance will be used in the preliminary work necessary to carry on the surveys planned for 1913.

*Allotment to Alaska surveys and investigations in 1912.*

Southeastern Alaska .....	\$2, 000
Copper River region.....	20, 500
Prince William Sound and Kodiak Island.....	23, 800
Yukon basin .....	15, 000
Northeastern Alaska.....	5, 000
General investigations.....	7, 700
Unallotted .....	16, 000
Total .....	90, 000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same party or even the same man may have carried on two different kinds of work, but this statement will help to elucidate a later table, which will summarize the complete areal surveys. This, like the previous table, includes an unallotted balance, which will be used for moving supplies and other service in preparation for field work in 1913.

*Approximate allotments to different kinds of surveys and investigations in 1912.*

Detailed geologic surveys.....	\$15, 600
Geologic reconnaissance surveys.....	3, 500
Special geologic investigations.....	12, 000
Detailed topographic surveys.....	18, 200
Investigation of water resources.....	5, 000
Collection of statistics of mineral production.....	1, 100
Miscellaneous, including clerical salaries, administration, inspection, instruments, office supplies, and equipment..	18, 600
Unallotted .....	16, 000
Total .....	90, 000

*Allotments for salaries and field expenses, 1912.*

Scientific and technical salaries .....	\$36, 970
Field expenses.....	18, 370
Clerical and other office and miscellaneous expenses.....	18, 660
Unallotted .....	16, 000
Total .....	90, 000

The following table exhibits the progress of investigations in Alaska and the annual grant of funds since systematic surveys were begun, in 1898. It should be noted that a varying amount is expended from year to year on special investigations, yielding results which can not be expressed areally.

*Progress of surveys in Alaska, 1898-1912.*

\* The Coast and Geodetic and International Boundary surveys have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

*General work.*—Alfred H. Brooks, geologist in charge, was employed in office work of the Alaska division until August 31, when he was appointed vice chairman of the Alaska Railroad Commission. Most of his time to the middle of February was devoted to work of the commission. During this period the administration of the Alaska division was in the hands of George C. Martin, as acting geologist in charge.

Mr. Brooks, in company with the other members of the commission (Maj. J. J. Morrow, Engineer Corps, United States Army, chairman; L. M. Cox, civil engineer, United States Navy, and C. M. Ingersoll), left Washington for Alaska on September 2 and, returning, reached Washington November 27. About two months were devoted to investigations in Alaska, during the course of which Kattalla, the Kenai Peninsula, the Willow Creek district, Valdez, Cordova, Fairbanks, Chitina, Haines, Skagway, and Juneau were visited. The commission was charged specifically with the duty of investigating the transportation problem and railway routes. Incidentally considerable data on mining developments were collected.

Of the 125 days devoted to Survey work in the office during the fiscal year 1913, the geologist in charge has spent about 15 days in reading and revising manuscripts, 16 days in preparing matter for the progress report, 4 days in miscellaneous writing, 2 days in preparing the annual press bulletin, 8 days on statistics of mineral production, 14 days on field plans, 18 days on work of the committee on the new Survey building, and the remainder on routine and miscellaneous matters.

R. H. Sargent continued the general supervision of the topographic surveys and map compilation, in addition to carrying on his own field work. Mr. Sargent devoted 54 days of office work to compilation of maps for the Alaska Railroad Commission.

E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during Mr. Brooks's absence in the field. He also continued to assist in collecting statistics of the production of precious metals in Alaska.

Arthur Hollick was employed for about nine months and continued the study of the fossil flora of the coal measures of Alaska.

*Southeastern Alaska.*—E. F. Burchard left Seattle on August 29 and spent a month in visiting the deposits of marble of the Wrangell and Ketchikan districts, in southeastern Alaska. C. W. Wright was employed for some two and a half months during the summer in completing his report, "Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska."

*Copper River region.*—D. C. Witherspoon, assisted by S. A. Witherspoon, began topographic work in the Kotsina district on July

19 and continued until September 30, completing the areal mapping of some 80 square miles on a scale of 1 mile to the inch, with contour intervals of 100 feet. This mapping covers part of an important copper-bearing district and will be extended westward in 1913. The geologic mapping and study of the ore deposits of this district were assigned to F. H. Moffit, assisted by Theodore Chapin and J. B. Mertie. Unfortunately, there were not sufficient funds to permit putting in a separate geologic party, and therefore Mr. Chapin was detailed to accompany Mr. Witherspoon and do such work from his camp as circumstances permitted. Mr. Moffit and Mr. Mertie spent about three weeks in September in the same district but were prevented from continuing the work because of a lack of provisions and feed, the railroad to Cordova being blocked for six weeks. The Moffit party mapped in all about 65 square miles, but another season's work will be required to extend the geologic survey over the important part of the district and to investigate the many prospects and mines.

*Prince William Sound.*—The detailed topographic mapping of what was then the most important part of the Valdez district was completed by J. W. Bagley in 1911. Since that time important prospects had been discovered to the west of the mapped area, and it therefore seemed desirable to extend work in this field. Mr. Bagley was detailed for this work and was employed on it from August 30 until October 23, during which time he mapped 128 square miles, for publication on a scale of 1 mile to the inch, with 50-foot contours.

The region immediately tributary to Landlocked Bay and to Ellamar is one of the best developed of the copper-bearing districts of Prince William Sound. For this reason a detailed geologic and topographic survey seemed desirable. The topographic work was assigned to R. H. Sargent, assisted by C. E. Giffen. Work was begun on August 26 and continued until October 13, a total of 90 square miles, for publication on a scale of 1 mile to the inch, with 100-foot contours, being mapped.

S. R. Capps and B. L. Johnson were assigned to make geologic surveys of the same district. They began work on August 26 and continued until October 9. A detailed geologic survey and investigation of mineral deposits were completed to cover an area of about 60 square miles.

*Kodiak Island.*—In the aggregate there has been much prospecting for auriferous lodes on Kodiak Island, and this, together with the fact that considerable mining is done each year on the beach placers, made an investigation of the resources of the island desirable. Plans for carrying on this work systematically in the summer of 1912 were formulated, but owing to the condition of the appropriation they could not be executed. An additional deterrent was the volcanic

eruption of June 6 to 8, which covered many of the outcrops with large quantities of volcanic tuff. An investigation of this volcanic eruption was desirable, not only because of its scientific interest but also because of the bearing it had on the industrial advancement of this part of the Territory. Unfortunately, the Geological Survey had no funds that could be devoted to this purpose. The National Geographic Society, however, offered a grant which made it possible to dispatch George C. Martin to this field. Mr. Martin spent about a month in investigating the distribution of the volcanic tuff, and from July 4 to September 4 made observations on the occurrence of metalliferous deposits in the island.

*Yukon Basin.*—The investigation of the water resources in the Yukon-Tanana region, which was begun at Fairbanks in 1907, was continued in 1912. C. E. Ellsworth and R. W. Davenport began work in the Fortymile district on May 20. Later Mr. Ellsworth extended the investigation through the Circle and Fairbanks districts, while Mr. Davenport continued stream gaging in the Fortymile district. This work was continued until September 15, 20 gaging stations being maintained in the Fortymile district for an average of 11 weeks each and 106 measurements being made. The results give information regarding the run-off of about 6,000 square miles. In the Eagle and Seventymile districts 13 gaging stations were maintained for an average of 15 weeks each and 70 measurements were made. The results give data relating to the run-off of about 600 square miles. Some 20 gaging stations were maintained in the Birch Creek district for an average of 14 weeks each and 123 measurements were made. This investigation indicates the run-off from about 2,150 square miles. In the Fairbanks district 16 gaging stations were maintained for an average of 14 weeks each and 82 measurements were made. The data thus obtained give information in regard to the run-off of about 2,000 square miles.

The rapid development in lode mining in the Fairbanks district since the detailed surveys were completed two years ago made further investigations desirable. For this reason P. S. Smith was detailed to go to Fairbanks as soon as money was available and investigate the auriferous lode deposits in such detail as time permitted. Mr. Smith spent from September 7 to 25 in this investigation.

There have been many demands made on the Survey for investigation of the Ruby placer district. Unfortunately the circumstances already recounted made it impossible to put a large party in this field. H. M. Eakin, however, was detailed to investigate the Ruby district and also to supplement previous investigations in the Innoko and Iditarod districts. Mr. Eakin reached Ruby on July 18, and after examining this district made an overland trip to Innoko and the Iditarod, traveling on foot and without pack horses.

*Northwestern Alaska.*—By courtesy of the boundary commissioner, Mr. O. H. Tittmann, the Survey was enabled to continue its geologic investigations along the international boundary north of Porcupine River. A. G. Maddren, assisted by J. M. Jessup and G. L. Harrington, was detailed for this work. Field work was begun on June 14 and continued until August 25. The topographic maps of the boundary surveyors (scale, 1:45,000) were used as a basis, and the areal mapping covered 400 square miles. The work was carried northward to the shores of the Arctic Ocean. In the course of two seasons Mr. Maddren has carried a geologic survey from Porcupine River northward to the Arctic, covering an area of about 800 square miles. This will do much to help elucidate some of the general geologic problems of Alaska. Dr. R. W. Brock, Director of the Geological Survey of Canada, had agreed to carry the work southward from the Porcupine to the Yukon. As this work also has been finished, fairly complete information has thus been collected regarding the geology of a belt stretching northward from the Yukon near Eagle to the Arctic Ocean, a distance of nearly 400 miles.

#### FIELD OPERATIONS FOR SEASON OF 1913.

The field work in 1913 was again delayed because no funds were available until the approval of the sundry civil act on June 23, 1913. With the available funds it was possible to take up only some of the more urgent work at the opening of the field season.

P. S. Smith, who was detailed to investigate the gold deposits and stratigraphy of the eastern part of the Ketchikan district, began work in May.

J. W. Bagley was dispatched to carry a topographic reconnaissance survey westward from Valdez Creek along the base of the Alaska Range to Broad Pass. F. H. Moffit, assisted by J. E. Pogue, undertook a geologic reconnaissance survey of the same region. These parties left Seattle May 24.

C. E. Ellsworth and R. W. Davenport were detailed to make a reconnaissance of the water supply of the lower Copper River Basin of the eastern part of the Prince William Sound region and of Kenai Peninsula. They began field work at Valdez in May.

H. M. Eakin was dispatched to make an exploratory survey from the mouth of Dall River to the lower Koyukuk River. He left Seattle on June 6.

C. E. Giffen was sent to Valdez to begin a survey of the region adjacent to the military road as far as Thomas Pass. He began work on June 2.

The delayed party chiefs, who started for the field after the new appropriation became available, are as follows:



Theodore Chapin undertook a geologic reconnaissance of the Yakataga district. D. C. Witherspoon was sent to complete the detailed topographic survey of the Kotsina district. To R. H. Sargent was assigned the task of making a detailed topographic survey of the eastern part of the Matanuska coal field. G. C. Martin, assisted by J. B. Mertie and R. M. Overbeck, undertook a geologic survey of the same field. To C. E. Giffin was assigned the task of making a detailed topographic survey of the Willow Creek district, while S. R. Capps is to map the geology of the same area. A. G. Maddren was detailed to study the placer deposits tributary to the lower Matanuska. The continuation of the study of the geology and mineral resources of Prince William Sound was assigned to B. L. Johnson.

Mr. Brooks left for Alaska on June 28, with the purpose of visiting south-central Alaska and studying the geology in the vicinity of Ellamar, Prince William Sound, with B. L. Johnson.

#### COLLECTION OF STATISTICS.

The work of collecting statistics of the annual production of gold, silver, and copper in Alaska, begun in 1906, was continued during the year. The progress report for 1912 was completed in June, 1913, and is in press as Bulletin 542. Figures on mineral production, which were also included in the report, were transmitted in June for inclusion in the Survey's annual volume "Mineral Resources of the United States" for the calendar year 1912.

#### OFFICE WORK.

During the year seven bulletins (Nos. 498, 501, 502, 520, 532, 534, and 535) and one water-supply paper (No. 314) relating to Alaska have been issued. Five bulletins are in press (Nos. 525, 526, 533, 536, and 538). All these publications contain maps. In addition, a map of Alaska showing the distribution of mineral resources (Alaska map B) has been issued as a sale publication. The following reports have been completed, and illustrations for them are being prepared:

The Hanagita-Bremner region, Alaska, by F. H. Moffit (Bulletin —); including topographic and geologic reconnaissance maps.

Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska, by C. W. Wright (Professional Paper —); including detailed geologic and topographic maps.

The surface water supply of the Yukon-Tanana region, by C. E. Ellsworth and R. W. Davenport (Water-Supply Paper —); including topographic reconnaissance map.

The Ruby-Iditarod region, by H. M. Eakin (Bulletin —); including geologic and topographic reconnaissance maps.

Contributions to the geology of Kenai Peninsula, by G. C. Martin, U. S. Grant, and B. L. Johnson (Bulletin —); including geologic and topographic reconnaissance maps.

Mineral resources of Alaska: Report on progress of investigations in 1912, by Alfred H. Brooks and others (Bulletin 542).

The following reports are in hand:

Geology of Glacier Bay and Lituya region, by F. E. Wright and C. W. Wright; including geologic reconnaissance maps.

The geology and mineral resources of the Ellamar district, Prince William Sound, Alaska, by S. R. Capps and B. L. Johnson; including geologic and topographic detailed maps.

Geology along the international boundary from Porcupine River to Arctic Ocean, by A. G. Maddren; including detailed geologic maps.

The office work on 13 topographic maps was completed during the year, as follows:

Chitina quadrangle (new edition), by T. G. Gerdine, D. C. Witherspoon, and others; scale, 1:250,000; contour interval, 200 feet.

Moose Pass and vicinity, by J. W. Bagley; scale, 1:62,500; contour interval, 50 feet.

Kenai Peninsula (reconnaissance map), by R. H. Sargent and J. W. Bagley; scale, 1:250,000; contour interval, 200 feet.

Fortymile quadrangle (new edition), by E. C. Barnard; scale, 1:250,000; contour interval, 200 feet.

Circle quadrangle (new edition), by D. C. Witherspoon, J. W. Bagley, and others; scale, 1:250,000; contour interval, 200 feet.

Fairbanks quadrangle (new edition), by T. G. Gerdine, D. C. Witherspoon, and R. H. Sargent; scale, 1:200,000; contour interval, 200 feet.

Rampart quadrangle (new edition), by D. C. Witherspoon and R. B. Oliver; scale, 1:250,000; contour interval, 200 feet.

Ruby-Iditarod region (reconnaissance map), by C. G. Anderson; scale, 1:250,000; contour interval, 200 feet.

Middle Kuskokwim and lower Yukon region (reconnaissance map), by C. G. Anderson and others; scale, 1:500,000; contour interval 200 feet.

Noatak-Kobuk region (reconnaissance map), by C. E. Giffin and D. L. Rea-burn; scale, 1:500,000; contour interval, 200 feet.

Koyukuk-Chandalar region (reconnaissance map), by T. G. Gerdine and A. G. Maddren; scale, 1:500,000; contour interval, 500 feet.

Nome quadrangle (new edition), by T. G. Gerdine; scale, 1:62,500; contour interval, 25 feet.

Grand Central quadrangle (new edition), by T. G. Gerdine; scale, 1:62,500; contour interval, 25 feet.

The following maps are in hand:

Ellamar and vicinity, by R. H. Sargent and C. E. Giffin; scale, 1:62,500; contour interval, 100 feet.

Valdez Bay and vicinity, by J. W. Bagley and C. E. Giffin; scale, 1:62,500; contour interval, 50 feet.

Kuskulana district, by D. C. Witherspoon; scale, 1:62,500; contour interval, 100 feet.

Yukon-Tanana region (compiled map); scale, 1:500,000; contour interval, 400 feet.

## SCIENTIFIC RESULTS.

Mr. Moffit and Mr. Chapin found a limestone carrying Carboniferous fossils, the first Paleozoic rocks found on the north side of the Chitina Valley. Mr. Chapin and Mr. Johnson found evidence of extensive thrust faulting in the Ellamar district of the Prince William Sound region.

Mr. Martin collected a large amount of data relating to the eruption of Mount Katmai, June 6 to 8. His work indicates that the geology of Kodiak Island is very similar to that of Kenai Peninsula. Mr. Maddren obtained evidence of a great thickness of Carboniferous sediments in the vicinity of the boundary north of the Porcupine. These rocks are divisible into at least five formations, three of which are probably Mississippian and two Pennsylvanian.

Hydrometric data obtained by C. E. Ellsworth, R. W. Davenport, and E. A. Porter during 1911 and 1912 show that the discharge of Yukon River at Eagle, Alaska, varied from a minimum of 10,100 second-feet on April 24, 1911, before the ice had gone out, to a maximum of 253,000 second-feet on May 22, 1911. Using the best climatic data available, they compute the run-off at 68 per cent of the precipitation.

## DIVISION OF MINERAL RESOURCES.

The most important change in the work of the division of mineral resources that has been made during the last two years has been in the more comprehensive treatment of the sources from which the mineral products of the country are obtained and the application of these products in the useful arts. The report "Mineral resources of the United States, calendar year 1912," will complete the third decade of the work of this division, which was first authorized by Congress August 7, 1882, by a provision added to the general appropriation for the Geological Survey to the effect that "not to exceed ten thousand dollars of the amount appropriated in this paragraph may be applied under the direction of the Secretary of the Interior to the procuring of statistics in relation to mines and mining other than gold and silver and in making chemical analyses of iron, coal, and oil." With the meager appropriation available at that time it was possible to print in the reports only statistical estimates prepared by experts on the various subjects, with more or less extended reviews of market conditions and some special contributions on mining localities, mining methods, and technical progress. This plan prevailed during the first two decades after the organization of the work. During the last ten years most of the reports have been prepared by geologists of the Survey who have specialized in the subjects treated by them, with a view to carrying out the provision of the organic act of the Survey which directs it to classify the public

lands and to examine the geologic structure, mineral resources, and products of the national domain.

The statistical treatment has now been developed to a high degree of exactitude, and the statements of production, consumption, etc., presented in the volume are the results of an annual census of the entire mineral industry. The statistical tables are compiled from reports received from over 60,000 operators and represent the output of between 75,000 and 100,000 mines, quarries, and wells. An instance of the more comprehensive study of the sources of the Nation's mineral wealth is presented in the report on the production of iron ores, pig iron, and steel in 1908, containing maps and brief descriptions of the different fields, showing the occurrence of the ores and the location of the blast furnaces. A map showing the geographic distribution of the production of precious and semiprecious metals in the Western States was published in 1908. The report on the production of coal in 1910 contains maps of the various coal areas of the United States, and the report on the stone industry in 1911 contains maps showing the localities of the quarrying operations, by varieties of stone, in the Eastern States, and similar maps covering the Central States will be published in the reports on this subject for 1912 and 1913. It is proposed that the clay resources shall be similarly treated, for it is recognized that in no other branch of the mining industry is the economic and sociologic progress of a country better illustrated than in the development of those products which are used in the construction of buildings and in civic improvements. An accurate knowledge of nature's storehouse from which future supplies are to be drawn and the tracing of these supplies from crude to finished products are recognized as of paramount importance. To obtain this knowledge as well as to record the history of past achievement is the purpose and aim of the division of mineral resources.

The chapter on the distribution of the useful minerals of the United States, which was referred to in the last annual report and which was prepared under the direction of the division of mineral resources, was found on completion to be too voluminous for publication in the annual volume of mineral resources and will be issued as a bulletin.

The plan of cooperation between the Geological Survey and the State surveys in the collection of most of the mineral statistics continued in force in connection with the report for 1912. The 15 States which cooperated were Alabama, Georgia, Iowa, Kansas, Maryland, Michigan, Missouri, New Jersey, North Carolina, Oklahoma, Oregon, Pennsylvania, Virginia, Washington, and Wisconsin. As this cooperation becomes better appreciated, both by the force of the division of mineral resources and by the State surveys, and is better understood by the producers, it works more and more smoothly,

the experience in 1912 having been the most satisfactory yet obtained. It obviates the duplication of a considerable amount of work and, so far as applied, it saves the producers the annoyance of preparing two sets of statistical reports.

During the fiscal year the work of the division consisted of the preparation of reports on the mineral production of the United States in the calendar years 1911 and 1912. The report for 1911 was published early in the calendar year 1913 (the latter half of the fiscal year), and the work on the report for 1912 was well advanced at the close of the fiscal year. This indicates that work on two different reports on the mineral resources of the United States was carried on during the fiscal year 1913. Although the report for 1911 was not published until early in the calendar year 1913, the separate chapters on all the subjects except one were published during the calendar year 1912. The energies of the entire force of the division have been directed toward the more prompt publication of the reports, as well as toward obtaining more complete information regarding the mining industries, and especially the sources of production. At the close of the fiscal year 1912 the manuscript of 30 chapters from the report for the calendar year 1911 had been completed and transmitted to the printer. On June 30, 1913, 34 chapters for the report for 1912 had been completed and transmitted to the printer.

The following table gives the estimated percentage of schedules returned at the close of the fiscal years 1909, 1910, 1911, 1912, and 1913 for some of the more important products, the period covered by the returns being the preceding calendar year:

*Percentage of schedules returned from producers at the end of fiscal years 1909, 1910, 1911, 1912, and 1913.*

Industry.	June 30, 1909.	June 30, 1910.	June 30, 1911.	June 30, 1912.	June 30, 1913.
Building stone.....	97	26	90	95	100
Clay working.....	98	35	95	100	100
Coal.....	98	26	99	100	100
Coke.....	100	15	100	100	100
Iron ore.....	100	24	100	100	100
Natural gas.....	90	43	80	95	100
Quicksilver.....	99	33	100	100	100

Preliminary estimates of the production of the following minerals in 1912, with reviews of the conditions which prevailed during the year, were given to the press in the form of special press bulletins during the latter part of December, 1912, and in January, 1913:

Cement.	Lead.	Uranium.
Coal.	Petroleum.	Vanadium.
Copper.	Rutile.	Western metal mfging.
Gold and silver mining.	Quicksilver.	Zinc.
Iron ores.	Tungsten.	

Advance statements giving the final official figures covering the production of copper, lead, and zinc in 1912 have also been published. Advance chapters from the report for 1912 on the following subjects (34 in all) have been published or are in press:

Chromic iron ore.	Pottery.
Fuel briquetting.	Silver, copper, etc., in the Central States (mine report).
Graphite.	Talc and soapstone.
Slate.	Asphalt.
Abrasives.	Coke.
Anthracite.	Fuller's earth.
Asbestos.	Peat.
Feldspar and quartz.	Barytes.
Fluorspar and cryolite.	Gypsum.
Mica.	Antimony, etc.
Sand-lime brick.	Manganese.
Bauxite and aluminum.	Quicksilver.
Cement.	Gold, silver, etc., in South Dakota and Wyoming (mine report).
Gems and precious stones.	Sand and gravel.
Gold, silver, etc., in the Eastern States (mine report).	Phosphate rock.
Potash salts.	Borax.
Commercial qualities of the slates of the United States and their localities.	Sulphur and pyrite.

The plan of assigning to geologists the study of the mineral products and the preparation of the reports thereon, which was adopted several years ago, was continued in 1913 and has brought eminently satisfactory results. As stated in the report for 1911, this plan gives to the statistical work the benefit of the cooperation of the geologist trained in economic work and gives to the geologist the opportunity to study the industrial and commercial conditions which affect the demand for the minerals. This method is also economical because the division of mineral resources does not usually require the entire time of the geologist but allows him opportunity to engage in his scientific pursuits, thus obligating the division to pay simply for the actual cost of its work.

The number of permanent employees in Washington who devote their entire time to the work of the division of mineral resources is 31, and 8 persons are employed in the offices of the division outside of Washington—at Salt Lake City, Denver, and San Francisco. In addition to these employees, 17 members of other divisions of the Survey, chiefly geologists, devote a portion of their time to the work of the division of mineral resources, making a total of 56 persons who devote the whole or a portion of their time to the work.

During the year 156,880 pieces of first-class mail matter (chiefly statistical inquiries) were sent out by the division, and 64,405 pieces were received.



E. W. Parker continued as administrative head of the division and chief of the section of nonmetallic resources. Waldemar Lindgren was chief of the section of metallic resources during a portion of the year and was succeeded in November, 1912, by H. D. McCaskey. Besides performing administrative duties Mr. Parker prepared the introductory chapter on mineral products and the reports on the production of coal, the manufacture of coke, and the briquetting industry. E. S. Bastin was in charge of the preparation of the report on graphite; E. F. Burchard, cement, fluorspar and cryolite, stone, iron ore, pig iron, and steel; B. S. Butler, copper (general report), copper and silver in Michigan (mine report); A. T. Coons, slate; C. A. Davis (of the Bureau of Mines), peat; D. T. Day, asphalt and bituminous rock, natural gas, petroleum, platinum and allied metals; J. S. Diller, asbestos, chromite, talc, and soapstone; J. P. Dunlop, silver, copper, lead, and zinc in the Central States (mine report), secondary metals and metallic ores (summary report); H. S. Gale, borax, magnesite, nitrates; F. L. Hess, antimony, arsenic, bismuth, cobalt, molybdenum, nickel, selenium, tantalum, tungsten, titanium, vanadium, uranium, tin; D. F. Hewett, manganese; J. M. Hill, barytes, mineral paints, strontium ore; F. J. Katz, abrasives, feldspar, and quartz; H. D. McCaskey, gold and silver (general report), precious and semiprecious metals in the Eastern States (mine report), quicksilver; G. C. Matson, mineral waters; Jefferson Middleton, clay, clay-working industries, fuller's earth, sand-lime brick; W. C. Phalen, bauxite and aluminum, phosphate rock, potash salts, salt and bromine, sodium salts, sulphur and pyrite; C. E. Siebenthal, lead, zinc, and cadmium (general reports); D. B. Sterrett, gems and precious stones, mica; R. W. Stone, glass, sand, other sand and gravel, gypsum, lime; W. T. Thom, summary of the mineral production; C. G. Yale, borax and magnesite (with H. S. Gale).

In addition to preparing his reports and performing supervisory work in Washington, Mr. McCaskey exercises general supervision of the offices of the division in the Western States. These offices are under the direct charge of the following persons: Denver, C. W. Henderson; Salt Lake City, V. C. Heikes; San Francisco, C. G. Yale. These persons prepare the various mine reports on gold, silver, copper, lead, and zinc in the Western States.

#### DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

In the chemical laboratory 560 quantitative analyses were reported during the year, and also 874 qualitative determinations, chiefly of minerals sent for examination by persons not connected with the Survey.

F. W. Clarke was largely occupied by the usual administrative routine. He also prepared two bulletins, one on the water analyses

made in the Survey laboratory, the other on the constitution of the natural silicates, and two short papers for outside publication—"An aluminum arsenate from Utah" and "Notes on chemical stability."

George Steiger's time was mostly given to routine analytical work but included some research on heavy metals in deep-sea deposits. He assisted Mr. Clarke in the administrative work, in ordering supplies for the laboratory, and in examining civil-service papers.

R. C. Wells was engaged chiefly in experimental work involving the application of physico-chemical methods to geochemistry, such as the determination of the colloidal matter in bentonite, the pore space in the ore-bearing rocks at Leadville, the behavior of maximum thermometers for taking earth temperatures, the solubility of sphalerite in solutions resembling natural waters, the preparation of gold-lead junctions by electrolysis for the purpose of studying the diffusion of gold in lead, and the electrochemical behavior of conducting ores. He contributed to outside publications papers on "The interpretation of mineral analyses" and "The electrical potentials between conducting minerals and solution," and prepared the data on the latter subject for publication as a bulletin.

Chase Palmer devised a method for determining relative proportions of sulpharsenides in arsenides and diarsenides, introduced a chemical reagent for recognition of certain metallic minerals in metallographic studies, and did experimental work on a natural occurrence of gold associated with selenium. He prepared papers in cooperation with E. S. Bastin, of the division of geology, as follows: "The rôle of certain metallic minerals as precipitants of silver and gold," published in the Bulletin of the American Institute of Mining Engineers; and "Metallic minerals as precipitants of silver and gold," published in Economic Geology. A third paper, in the form of an address, entitled "A new classification of natural waters" was read at the annual meeting of the Geological Society of America in New Haven, Conn.

W. T. Schaller was reinstated in the Survey October 1, on his return from Europe, where he had spent the summer studying mineralogy. His paper on the mineral tourmaline, based on work done in this laboratory, was accepted by the University of Munich as a doctorate dissertation. Most of his time has been devoted to routine analytical work consisting of chemical and mineralogical determinations and quantitative rock and mineral analyses. He studied the minerals bloedite, melilite, and custerite (a new mineral) and began an investigation of several apparently new borates from California, a new aluminum phosphate from Utah, a new titanium mineral from Colorado, a new zinc silicate from New Jersey, and a new alteration product of melilite. Crystals of pisanite from Ducktown, Tenn., were measured and described for Prof. Van Horn, of

the Case School of Applied Science in Cleveland. Mr. Schaller's report on the gem tourmaline field of California was finished and submitted for publication. He made a visit to New York to obtain material for illustrating this report. He obtained for study the entire collection of schneebergite from the Vienna Hof Museum and has procured specimens of atopite from Brazil and of romeine from Italy for comparative study. He has begun a study of the mineral composition of phosphate rock and has obtained numerous samples of such minerals from England, France, Germany, Russia, and the United States.

The following papers by Mr. Schaller have been published in outside journals: "Immense bloedite crystals from California," "Calculation of mineral formulas," "Refractive indices of strengite," "Crystallography of natramblybonite," and "The tourmaline group." He also prepared several other minor papers for publication.

During Mr. Schaller's absence in Europe his position was filled by a substitute, Prof. W. F. Hunt, of Ann Arbor, Mich.

J. G. Fairchild left the Survey on leave of absence on August 26, and W. C. Wheeler was appointed to fill the supposed temporary vacancy. On November 23, 1912, Mr. Fairchild resigned and Mr. Wheeler received the permanent appointment. Mr. Wheeler's entire time has been given to routine analytical work.

Two chemists were added to the force on account of the potash appropriation, W. B. Hicks in October, 1912, and R. K. Bailey in December, 1912. They are engaged in routine analytical work relating to the potash investigation.

In the physical laboratory C. E. Van Orstrand designed and supervised the construction of apparatus for measuring the temperature of deep wells. Some preliminary observations were made in the field by Mr. Van Orstrand, in cooperation with G. F. Becker, during the month of June. Experiments on elasticity and plasticity were resumed after the probationary appointment on March 1 of A. F. Melcher, of Chicago, Ill., as assistant physical geologist. The following papers by Mr. Van Orstrand, the first two of which are of the nature of preliminary reports, were published in the Journal of the Washington Academy of Sciences: "A table of the circular functions to radian argument," "Tables of the exponential function," and "The determination of the order of agreement between observations and theory in mineral analyses" (in cooperation with F. E. Wright).

G. F. Becker was employed in studying finite flexure, extension and torsion of elastic bodies, and thermometric indications of bubbles in fluid inclusions, and in devising thermometric appliances for taking earth temperatures in bore holes. He spent the month of February, 1913, in Panama, observing the slides in the Culebra Cut,

and has since been occupied in studying the mechanics of the phenomena. He published a paper (which has a geophysical bearing) on the "Guderniannian complement and imaginary geometry."

### TOPOGRAPHIC BRANCH.

#### ORGANIZATION.

A reorganization of the field service of the topographic branch was effected on July 1 last, as outlined in the annual report for the last fiscal year. The present organization is as follows:

Chief geographer, R. B. Marshall.

Atlantic division, Frank Sutton, geographer in charge.

Central division, W. H. Herron, geographer in charge.

Rocky Mountain division, Sledge Tatum, geographer in charge.

Northwestern division, T. G. Gerdine, geographer in charge.

Pacific division, George R. Davis, geographer in charge.

Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman, topographic engineer.

#### PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 1 topographic engineer, 1 assistant topographer, 16 junior topographers, and 1 draftsman. It was reduced 25 by transfers, resignations, and deaths. With these changes the technical force now includes 1 chief geographer, 11 geographers, 17 topographic engineers, 36 topographers, 37 assistant topographers, 54 junior topographers, and 10 draftsmen—a total of 166. In addition, 54 technical field assistants were employed during a whole or a part of the field season. One geographer, 1 topographer, and 1 assistant topographer are on leave without pay.

#### PUBLICATIONS.

The published work of the topographic branch for the fiscal year consists of 101 maps and 6 book publications, namely, Bulletins 514, 515, 516, 517, 518, and 519, titles and brief summaries of which are given on page 18; also the "Topographic instructions," two prints of which have been received, and a book for facilitating primary traverse computations entitled "Logarithms and factors for converting latitudes and departures in feet to seconds of latitude and longitude for latitudes 0° to 72°," prepared by D. H. Baldwin. The manuscripts for 17 bulletins have been assembled and transmitted for publication as results of spirit leveling, namely, Oregon, 1896 to 1911 (Bulletin 556); Washington, 1911, containing also the elevations published in Bulletin 457 affected by the 1912 adjustment (Bulletin

557); Wyoming, 1896 to 1911 (Bulletin 558); Michigan, 1911 (Bulletin 559); Minnesota, 1897 to 1912 (Bulletin 560); Hawaii, 1910 to 1912 (Bulletin 561); Virginia, 1911 and 1912 (Bulletin 562); Maryland, 1896 to 1911 (Bulletin 563); Oklahoma, 1895 to 1912 (Bulletin 564); Colorado, 1896 to 1912 (Bulletin 565); Utah, 1897 to 1912 (Bulletin 566); Idaho, 1896 to 1912 (Bulletin 567); Missouri, 1896 to 1912 (Bulletin 568); Iowa, 1896 to 1912 (Bulletin 569); Wisconsin, 1897 to 1912 (Bulletin 570); Kansas, 1896 to 1912 (Bulletin 571); and Nebraska, 1896 to 1912 (Bulletin 572). These publications also include, in addition to the results of the Geological Survey's leveling, similar data from other organizations, which have been added as appendices. In each publication is also given, where the number warrants it, a list of secondary elevations taken from the records of this Survey. The leveling data for Illinois and Kentucky for 1912 have been added to their respective manuscripts, which were submitted during the fiscal year 1911-12 for publication; and the results of primary triangulation and primary traverse in 1912 have been added to the manuscript containing the data for 1911, which was also transmitted for publication last year.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1913 were:

Topographic surveys.....	\$359, 200
Surveying national forests .....	75, 000
	<hr/> 434. 200

The allotments of the appropriations, which were adhered to so far as practicable, were as follows:

*Allotments from funds appropriated for topographic work, fiscal year 1913.*

	Topo- graphic surveys.	Surveying national forests.
Administrative expenses of Survey.....	\$22, 896	\$4, 500
Clerical assistance and supervision.....	16, 268	3, 332
Map editing.....	6, 225	1, 275
Purchase and repair of instruments, stationery, etc.....	12, 242	2, 508
Millionth-scale map.....	20, 000	.....
Atlantic division, field work in Alabama, District of Columbia, Georgia, Maine, Maryland, New York, Pennsylvania, Virginia, and West Virginia.....	73, 495	.....
Central division, field work in Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.....	56, 495	.....
Rocky Mountain division, field work in Colorado, Montana, Nebraska, Missouri, New Mexico, Oklahoma, and Wyoming.....	51, 092	19, 761
Pacific division, field work in Arizona, California, New Mexico, Nevada, Utah, and Hawaii.....	50, 292	25, 112
Northwestern division, field work in Idaho, Oregon, Montana, Wyoming, and Washington.....	39, 595	16, 012
Work by land-classification board.....	10, 000	2, 500
	<hr/> 359, 200	<hr/> 75, 000

## COOPERATION.

Cooperation has been maintained with several States, as described in previous reports. The States and the amounts allotted by them are as follows:

*Allotments for cooperative work.*

California .....	\$14, 000. 00
California river surveys, not met by Federal allotment..	3, 600. 00
Idaho .....	700. 00
Illinois .....	8, 000. 00
Iowa .....	2, 650. 00
Kentucky .....	10, 000. 00
Maine .....	3, 728. 42
Michigan .....	2, 000. 00
Minnesota .....	10, 362. 48
Missouri .....	2, 500. 00
Nebraska .....	2, 000. 00
New York .....	10, 000. 00
Ohio .....	25, 000. 00
Oklahoma .....	1, 000. 00
Oregon .....	15, 000. 00
Pennsylvania .....	5, 528. 19
Virginia .....	4, 250. 00
Washington .....	13, 750. 00
West Virginia .....	12, 000. 00
Hawaii .....	15, 200. 00
	<hr/>
	161, 267. 09

In addition to the amounts above listed the State of Oregon made an allotment, not met with Federal funds, for a profile survey of Deschutes River in that State, in connection with a special report on that river by the water-resources branch. An informal cooperative arrangement was also made with the Canadian Geological Survey for a special resurvey of the Niagara gorge, the work on both sides being done by members of the topographic branch, but the entire expense of the work on the Canadian side being borne by that Government.

## GENERAL OFFICE WORK.

Progress maps were kept up to date and new ones were compiled when necessary; for States of which the new millionth-scale maps were available, new progress maps were made; field notes in connection with vertical and horizontal control work were copied and catalogued; 92 civil-service examination papers for the positions of assistant topographer and topographic aid were rated.



The computations of control positions were made principally by D. H. Baldwin, T. M. Bannon, L. F. Biggs, R. H. Chapman, J. R. Ellis, G. T. Hawkins, Oscar Jones, C. B. Kendall, L. S. Leopold, F. J. McMaugh, and A. C. Roberts, the work being done under the immediate supervision of E. M. Douglas, geographer. S. S. Gannett, geographer, spent most of his time in preparing manuscript and compiling data for the bulletins heretofore mentioned.

#### SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1913, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 18,578 square miles, making the total area surveyed to date in the United States 1,178,974 square miles, or 38.9 per cent of the entire country. In addition, 3,987 square miles of resurvey were completed, making the total area of actual surveys during the year 22,565 square miles.

In connection with these surveys, 4,234 linear miles of primary levels were run, making 242,042 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,117 permanent bench marks were established. In addition, 884 linear miles of river surveys were run.

Triangulation stations to the number of 176 were occupied and 128 were permanently marked. Primary traverse lines aggregating 1,353 miles were run, in connection with which 173 permanent marks were set. In the course of this work 20,853 square miles were covered by primary control.

The area covered by topographic surveys in Alaska during the fiscal year, as reported in detail on page 76, was 298 square miles, for publication on the scale of 1:62,500.

Topographic surveys were also carried on in Hawaii, the area mapped during the fiscal year being 153 square miles, for publication on the scale of 1:31,680, making the total area surveyed to date in Hawaii 1,032 square miles. In connection with the surveys in Hawaii, 51 miles of primary and precise levels were run and 13 permanent bench marks were established, making the total number of miles of primary and precise levels run by this survey in Hawaii 490.

*Present condition of topographic surveys of the United States and new areas surveyed in fiscal year 1912-13.*

	New area surveyed in 1912-13.	Total area surveyed to June 30, 1913.	Percentage of total area of State surveyed to June 30, 1913.
	Sq. mi.	Sq. mi.	
Alabama.....		18,713	36
Arizona.....	2,299	66,700	58
Arkansas.....		21,380	40
California.....	6,133	109,444	69
Colorado.....	1,131	45,226	43
Connecticut.....		4,965	100
Delaware.....		1,208	51
District of Columbia.....		70	100
Florida.....		2,080	4
Georgia.....		17,337	29
Idaho.....	382	24,493	29
Illinois.....	1,018	13,128	23
Indiana.....		3,041	8
Iowa.....	305	11,371	20
Kansas.....		64,189	28
Kentucky.....	67	17,654	42
Louisiana.....		8,311	17
Maine.....	294	8,914	27
Maryland.....		12,327	160
Massachusetts.....		8,266	100
Michigan.....	306	5,591	9
Minnesota.....	434	5,572	6
Mississippi.....		1,899	4
Missouri.....	185	35,664	51
Montana.....	794	55,965	38
Nebraska.....	217	26,311	34
Nevada.....	7	50,662	46
New Hampshire.....		3,380	38
New Jersey.....		8,224	100
New Mexico.....	320	35,850	29
New York.....	622	42,227	85
North Carolina.....		17,661	34
North Dakota.....		9,716	14
Ohio.....	1,739	34,727	84
Oklahoma.....	397	39,612	56
Oregon.....	930	20,742	21
Pennsylvania.....	291	24,167	55
Rhode Island.....		1,248	100
South Carolina.....		5,640	18
South Dakota.....		18,594	24
Tennessee.....		20,911	50
Texas.....		67,387	26
Utah.....		67,905	79
Vermont.....		3,753	39
Virginia.....		29,980	70
Washington.....	650	23,269	23
West Virginia.....		24,170	100
Wisconsin.....		11,789	21
Wyoming.....	157	27,538	28
Hawaii.....	18,578 153	1,178,974 1,032	38.9 16

ATLANTIC DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Alabama, the District of Columbia, Maine, Maryland, New York, Pennsylvania, Virginia, and West Virginia. This work comprised the completion of the survey of five quadrangles and of the resurvey of five quadrangles and two special areas, in addition to which four

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quadrangles were partly surveyed and seven quadrangles were partly resurveyed. The total new area mapped was 1,207 square miles for publication on the scale of 1:62,500. The area resurveyed was 1,920 square miles—1,444 square miles for publication on the scale of 1:62,500, 465 square miles for publication on the scale of 1:24,000, and 11 square miles for publication on the scale of 1:12,000. In connection with this work 769 miles of primary levels were run and 174 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by nine parties, the work being distributed over portions of Alabama, Georgia, Maine, Maryland, Tennessee, Virginia, and West Virginia. The total area covered by this primary control was about 3,218 square miles, of which 675 square miles were controlled by primary traverse, 174 miles being run and 15 permanent marks set. Thirty-six triangulation stations were occupied and 33 were permanently marked. The result of this work was to make control available in fourteen quadrangles.

*Topographic surveys in Atlantic division from July 1, 1912, to June 30, 1913.*

State.	Contour interval.	For publication on scale of—				Total area surveyed.	Primary levels.		Primary traverse.	
		1:62,500		1:24,000	1:12,000, new.		Distance run.	Bench marks.	Distance run.	Permanent marks.
		New.	Resurvey.	Resurvey.						
	Feet.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Miles.		Miles.	
Alabama.....									50	6
District of Columbia.....	10			70		70	12	1		
Maine.....	20	294				294	89	23		
Maryland.....	10			245		245	35	7	47	6
New York.....	10-20	622			11	633	199	50		
Pennsylvania...	20	291	13			304	63	15		
Tennessee.....									35	3
Virginia.....	10-20-50		467	150		617	150	29	42	
West Virginia...	50		964			964	221	49		
		1,207	1,444	465	11	3,127	769	174	174	15

#### DETAILS OF WORK, BY STATES.

*Alabama.*—For the control of the Searles quadrangle, in Tuscaloosa and Jefferson counties, F. W. Crisp and C. W. Arnold ran 50 miles of primary traverse and set 6 permanent marks.

*District of Columbia-Maryland-Virginia.*—A special resurvey was made of the area around Washington, D. C., the map to be published as "Washington and vicinity," on the scale of 1:24,000, with a contour interval of 10 feet. The area resurveyed comprised 465 square miles, of which 70 covered the District of Columbia, 245 were in Maryland, and 150 were in Virginia. For the control of this area D. H. Baldwin, F. J. McMaugh, and R. C. Seitz ran 104 miles of

primary and precise levels and established 17 permanent bench marks, and G. W. Hawkins, C. B. Kendall, and J. R. Ellis ran 89 miles of primary traverse and set 6 permanent marks. Of this control, 35 miles of primary levels and 7 permanent bench marks and 47 miles of primary traverse and 6 permanent marks were in Maryland, 57 miles of primary levels and 9 permanent bench marks and 42 miles of primary traverse were in Virginia, and 12 miles of primary levels and 1 permanent bench mark were in the District of Columbia.

*Georgia.*—The Talking Rock and Waleska quadrangles, in Gilmer, Pickens, Gordon, and Cherokee counties, were controlled by triangulation, 6 stations being occupied and 5 permanently marked. This work was done by G. T. Hawkins.

*Maine.*—For the continuation of cooperative topographic surveys in Maine the State Survey Commission allotted \$3,650, which was met by the United States Geological Survey with an allotment of \$3,850, the reason for the larger Federal allotment being that during the previous fiscal year the State had contributed \$200 toward cooperative surveys not met by the Federal Government. In addition, the State Survey Commission contributed \$76.42 for the preparation of a special edition of a map of the Great Moose Lake for State use. The survey of the Bethel and Skowhegan quadrangles in Oxford and Somerset counties was completed by Hersey Munroe, Olinus Smith, and K. E. Schlachter, and that of the Waldoboro quadrangle, in Lincoln and Knox counties, was begun by W. H. Griffin and J. H. Le Feaver, the total area mapped being 294 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Washington Pond and Burnham quadrangles, in Waldo and Kennebec counties, G. T. Hawkins occupied 13 triangulation stations and permanently marked 11, and Mr. Schlachter, J. M. Perkins, and C. H. Davey ran 89 miles of primary levels and established 23 permanent bench marks.

*Maryland.*—For work in Maryland see pages 95–96 (map of Washington and vicinity).

*New York.*—The State engineer and surveyor of New York allotted \$10,000 for the continuation of cooperative topographic surveys in that State, and the Federal Survey allotted a like sum for the same purpose. The survey of the Number Four, Churubusco, and Corning quadrangles, in Lewis, Herkimer, Clinton, and Steuben counties, was completed, and that of the Bonaparte quadrangle, in Lewis, Herkimer, and St. Lawrence counties, was continued by J. M. Whitman, J. F. McBeth, W. H. S. Morey, T. F. Slaughter, S. P. Floore, R. A. Kiger, Roscoe Reeves, H. S. Senseney, and E. E. Witherspoon, the total area mapped being 622 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control



of these areas and of the Gouverneur quadrangle, in St. Lawrence County, Mr. Schlachter, Mr. Senseney, K. W. Trimble, and A. J. Kavanaugh ran 199 miles of primary levels and established 50 permanent bench marks.

Under a special arrangement with the Canadian Geological Survey a resurvey of the Niagara gorge was made by C. E. Cooke, for publication on the scale of 1:12,000, with a contour interval of 10 feet, the area mapped in the United States being 11 square miles. In addition, 17 square miles on the Canadian side were mapped by Mr. Cooke, his salary and the entire expense of the work in Canada being paid direct by the Canadian Geological Survey.

*Pennsylvania.*—The Topographic and Geologic Survey Commission of Pennsylvania allotted \$5,328.19 for the continuation of the cooperative topographic survey of the State, and the United States Geological Survey allotted a like sum. The survey of the Northeast and Somerset quadrangles, in Erie, Somerset, and Westmoreland counties, was begun by Robert Muldrow, W. H. Griffin, J. F. McBeth, and C. H. Davey, the area mapped being 291 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas L. F. Biggs ran 63 miles of primary levels and established 15 permanent bench marks.

In addition to the cooperative work in Pennsylvania, the resurvey of the Reading quadrangle, in Berks County, was begun by Hersey Munroe and Olinus Smith, the area mapped being 13 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

A special survey was also made for the Bureau of Mines of the site for the experiment station in Pittsburgh, covering an area of about 18 acres. All the expenses of this work except the salaries of the topographers were paid by the Bureau of Mines.

*Tennessee.*—For the control of the Murfreesboro quadrangle, in Rutherford County, Oscar Jones ran 35 miles of primary traverse and established 3 permanent marks.

*Virginia.*—For the continuation of cooperative topographic surveys in Virginia the State geologist allotted \$4,250 and the United States Geological Survey allotted an equal amount. In order to take advantage of favorable weather, the State money was made available for expenditure in June of the preceding fiscal year, and a portion of the work accomplished under the allotment was included in the report for that year. The resurvey of the Virginia portion of the Pound quadrangle, in Wise and Dickenson counties, was completed, and that of the Clintwood quadrangle, in the same counties, was begun, by J. I. Gayetty, J. B. Metcalfe, jr., F. W. Crisp, C. W. Arnold, F. W. Farnsworth, and Roscoe Reeves, the area mapped

being 232 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these areas and of the Bucu quadrangle, in Dickenson and Buchanan counties, Mr. Gayetty, Mr. Arnold, H. S. Senseney, and Mr. Metcalfe ran 89 miles of primary levels and established 19 permanent bench marks.

In addition to the cooperative work in Virginia, the resurvey of the Fairfax quadrangle (the northeast quarter of the Mount Vernon 30-foot quadrangle), in Fairfax, Prince William, and Loudoun counties, was completed by Robert Muldrow and R. C. McKinney, the area mapped being 196 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this quadrangle R. H. Kilmer ran 4 miles of primary levels and established 1 permanent bench mark. The resurvey of the Eagle Rock quadrangle (southeast quarter of the Natural Bridge 30-foot quadrangle), in Botetourt, Alleghany, and Craig counties, the mapping of which was begun in 1907-8, was continued by T. F. Slaughter, the area mapped being 39 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. (See also pp. 95-96, map of Washington and vicinity.)

*West Virginia.*—For the continuation of cooperative surveys the State geologist allotted \$12,000 and the United States Geological Survey \$10,000. A resurvey of areas previously mapped resulted in the completion of the survey of the Crawford, Sandrun, Packs Ferry, and Meadow Creek quadrangles and of portions of the Ingle-side, Hacker Valley, and Pickens quadrangles, in Lewis, Upshur, Randolph, Webster, Summers, Mercer, Raleigh, Monroe, and Greenbrier counties, the area mapped being 964 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by E. I. Ireland, J. I. Gayetty, Fred McLaughlin, S. A. Judson, J. H. Le Feaver, K. E. Schlachter, C. S. Wells, and M. A. Roudabush.

For the control of these areas and of the Peterstown, Winona, and Summersville quadrangles, in Mercer, Summers, Monroe, Fayette, Greenbrier, Clay, and Nicholas counties, Mr. Hawkins, Mr. Metcalfe, and Mr. Kendall occupied and permanently marked 17 triangulation stations, and Mr. Biggs, Mr. Metcalfe, and Mr. Trimble ran 221 miles of primary levels and established 49 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Seaford, Del.-Md.; Palatka, Fla.; Bethel and Skowhegan, Maine; Corning, Churubusco, Niagara Gorge, and Number Four, N. Y.; Murphy, N. C.-Tenn. (revision); Pound, Va.-Ky.; Crawford, Fairfax, Meadow Creek, Hinton, and Sago, W. Va.; Experiment Station, Bureau of *Mines*.

Progress in the drafting of additional sheets was made as follows: Washington and vicinity, D. C.-Md.-Va., 95 per cent; Northeast, Pa., 50 per cent; Somerset, Pa., 50 per cent; Fairfax, Va., 90 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted and geographic positions were computed for the Adger quadrangle (Ala.). Geographic positions for the Searles quadrangle (Ala.) were adjusted.

Primary-level circuits in the Seaford quadrangle (Del.-Md.) were adjusted.

Primary-level circuits were adjusted and geographic positions were computed for the Washington and vicinity quadrangle (D. C.-Md.-Va.).

Geographic distances and positions were computed for the Cartecay, Talking Rock, and Waleska quadrangles (Ga.).

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Skowhegan quadrangle (Maine). Primary-level circuits in the Anson, Bethel, and Kingsbury quadrangles (Maine) were adjusted, and geodetic distances and positions for the Burnham, Waldoboro, and Washington Pond quadrangles (Maine) were computed.

Primary-level circuits in the Crawford Notch and Mount Washington quadrangles (N. H.) were adjusted.

Primary-level circuits were adjusted and geographic positions were computed for the Bonaparte and Churubusco quadrangles (N. Y.). Primary-level circuits in the Corning quadrangle (N. Y.) were adjusted, and geographic positions for the Chateaugay, Edwards, and Gouverneur quadrangles (N. Y.) were computed.

Primary-level circuits were adjusted and geographic positions were computed for the Gastonia (N. C.) and Pleasantridge (N. C.-S. C.) quadrangles. Primary-level circuits in the Derita quadrangle (N. C.) were adjusted, and geographic positions in the Lincolnton quadrangle (N. C.) were computed.

Primary-level circuits in the Somerset quadrangle (Pa.) were adjusted.

Precise and primary level circuits in the island of Porto Rico, run by members of this Survey in connection with the work being conducted by the Porto Rico Irrigation Service, were adjusted.

Geographic positions for the Murfreesboro, Nolensville, and Woodbury quadrangles (Tenn.) were computed.

Primary-level circuits in the Burkes Garden, Coeburn, Glade Springs, Lebanon, Richlands, and Wise (Va.), Bigstone Gap, Clintwood, and Pennington Gap (Va.-Ky.), Maxwell (Va.-W. Va.), and Hagan, Middlesboro, and Sneedville (Va.-Tenn.-Ky.) quadrangles were adjusted.

Primary-level circuits in the Hinton, Meadowcreek, Pickens, and Sago quadrangles (W. Va.) were adjusted.

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Illinois, Iowa, Kentucky, Michigan, Minnesota, Missouri, and Ohio. This work comprised the completion of the survey of 22 quadrangles and of the resurvey of 3 quadrangles, in addition to which 12 quadrangles were partly surveyed, and 4 quadrangles were partly resurveyed. The total new area mapped was 3,820 square miles, for publication on the scale of 1:62,500; the area resurveyed was 802 square miles, for publication on the scale of 1:62,500. In addition 2 quadrangles were completely revised, the area covered being 463 square miles. In connection with this work 1,557 miles of primary levels were run and 415 permanent bench marks were established.

Primary traverse was carried on at different times by three parties, the work being distributed over portions of Illinois, Iowa, Michigan, Minnesota, Missouri, and Wisconsin. The total area covered by this primary control was about 1,935 square miles, 844 linear miles of primary transverse being run and 80 permanent marks set. The result of this work was to make control available in 34 quadrangles.

*Topographic surveys in central division from July 1, 1912, to June 30, 1913.*

State.	Contour interval.	For publication on scale of—		Total area surveyed.	Primary levels.		Primary traverse.	
		1: 62,500			Dis- tance.	Bench marks.	Dis- tance.	Perma- nent marks.
		New.	Resur- vey.					
	<i>Fect.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>	
Illinois.....	20	1,018	220	1,238	243	71	269	23
Iowa.....	20	305	.....	305	93	22	27	3
Kentucky.....	20-50	67	381	448	285	76	.....	.....
Michigan.....	20	206	.....	206	.....	.....	128	15
Minnesota.....	10	434	.....	434	378	109	99	11
Missouri.....	20	51	201	252	226	61	224	16
Ohio.....	10-20	1,739	.....	1,739	258	59	.....	.....
Wisconsin.....	.....	.....	.....	.....	74	17	97	12
.....	.....	3,820	802	4,622	1,557	415	844	80

DETAILS OF WORK BY STATES.

*Illinois.*—The governor of Illinois allotted \$8,000 for the continuation of cooperative topographic surveys in Illinois, and the United States Geological Survey allotted a like sum. The survey of the Macomb, Staunton, Centralia, and Baldwin quadrangles and of the Illinois portions of the Vincennes and Chester quadrangles, in McDonough, Schuyler, Macoupin, Marion, Clinton, Washington, Fay-

ette, Randolph, Monroe, St. Clair, Lawrence, and Wabash counties, was completed by Frank Tweedy, C. W. Goodlove, L. L. Lee, F. W. Hughes, J. H. Wilson, W. S. Gehres, S. R. Truesdell, and R. M. Herrington, the area mapped being 871 square miles for publication on the scale of 1:62,500, with a contour interval of 20 feet. The mapping of the Equality quadrangle and of the Illinois portion of the Shawneetown quadrangle, in Saline, Gallatin, Hardin, and Pope counties, was begun by O. H. Nelson, E. L. Hain, and F. B. Barrett, the area mapped being 147 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Ottawa quadrangle, in Lasalle County, was completed by L. L. Lee and L. H. Williams, the area mapped being 220 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Litchfield, New Douglas, and Alton quadrangles, in Montgomery, Macoupin, and Madison counties, Mr. Barrett, S. R. Archer, and R. G. Clinite ran 244 miles of primary levels and established 71 permanent bench marks. For the control of the Illinois portion of the Edgington quadrangle and of the Kings, Rochelle, Shabbona, Mendota, Plano, Marseilles, Morriss, Odell, Glasford, Muscatine, Keithsburg, Goodhope, Avon, Galesburg, and Elmwood quadrangles, in Ogle, Winnebago, Lee, Dekalb, Lasalle, Bureau, Kendall, Grundy, Peoria, Fulton, Rock Island, Mercer, Warren, Henderson, McDonough, Knox, and Stark counties, E. L. McNair and A. D. Duck ran 269 miles of primary traverse and set 23 permanent marks.

*Iowa.*—The State geologist allotted \$1,750 for the continuation of cooperative topographic surveys in Iowa, and the Federal Survey allotted an equal amount. In the spring of 1913 an additional allotment of \$900 was made by the State geologist for cooperative surveys, which was not met by the Federal Survey. The survey of the Story City quadrangle was completed and that of the Boone quadrangle, in Story, Boone, Hamilton, and Webster counties, was begun by W. L. Miller and C. R. French, the total area mapped being 305 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Chariton quadrangle in Lucas, Warren, and Marion counties, S. R. Archer and R. G. Clinite ran 93 miles primary levels and established 22 permanent bench marks. In addition to the cooperative work in Iowa, the Iowa portions of the Edgington and Durant quadrangles, in Muscatine, Scott, and Adair counties, were controlled by Mr. McNair and Mr. Duck, 27 miles of primary traverse being run, in connection with which 3 permanent marks were set.

*Kentucky.*—The Kentucky Geological Survey allotted \$10,000 for the continuation of cooperative topographic surveys in that State, and the Federal Survey allotted a like sum. The survey of the



Little Muddy quadrangle, in Warren and Butler counties, was completed by C. W. Goodlove and R. M. Herrington, the area mapped being 67 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Hindman quadrangle was completed, and that of the Oven Fork quadrangle begun, in Knott, Letcher, and Floyd counties, the area mapped being 288 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The resurvey of the Kentucky portions of the Pound and Clintwood quadrangles, in Pike and Letcher counties, was completed by J. I. Gayetty, F. W. Crisp, C. W. Arnold, Roscoe Reeves, and H. S. Senseney, the area mapped being 93 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The resurvey of the Virginia portions of the two last-named quadrangles was begun in cooperation with the State of Virginia. For the control of the above areas and of the Cornettsville, Laynesville, Goodloe, and Virgie quadrangles, in Martin, Pike, Floyd, Johnson, Magoffin, Breathitt, Letcher, Perry, and Leslie counties, S. R. Archer, C. W. Arnold, and H. S. Senseney ran 285 miles of primary levels and established 76 permanent bench marks. (See also p. 104, Ohio-Kentucky.)

*Michigan.*—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted \$2,000, which was met by the United States Geological Survey with a like sum. The mapping of the Grand Rapids quadrangle, in Kent, Barry, and Allegan counties, was completed by A. M. Walker and L. D. Townsend, the area mapped being 192 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the St. Charles, Carson City, Chesaning, De Witt, Elsie, Freeland, Ithaca, Merrill, Muir, Perrinton, and Saginaw quadrangles in Clinton, Gratiot, Saginaw, Eaton, and Midland counties, J. H. Wilson ran 128 miles of primary traverse and set 15 permanent marks.

In addition to the cooperative work in Michigan, the survey of the Houghton quadrangle, in Houghton County, was completed by Mr. Walker and Mr. Townsend, the area mapped being 14 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

*Minnesota.*—The State drainage engineer of Minnesota allotted \$10,000 for the continuation of cooperative topographic work in that State, and the United States Geological Survey made an equal allotment. A further allotment of \$362.48 was made by the State to cover additional expenditures on account of the cooperative work. The survey of the Deerwood quadrangle and the unmapped portions of the Battle Lake, Perham, and Dora quadrangles, in Aitkin, Crow Wing, Ottertail, Becker, and Clay counties, was completed by C. L. Sadler, F. B. Barrett, L. B. Roberts, E. L. Hain, O. H. Nelson, J. H. Wilson, and W. A. Reiter, the area mapped being 434 square miles,

for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of these areas and of the Pelican Rapids quadrangle, in Ottertail and Clay counties, J. M. Ray ran 115 miles of primary levels and set 32 permanent bench marks. For the control of the Aitkin, Emily, Brainerd, Wealthwood, Sylvan, Crosslake, McGregor, Haypoint, Lastrup, Rucker, and Opstead quadrangles, in Aitkin, Crow Wing, Cass, Morrison, Mille Lacs, and Kanabec counties, Mr. McNair and Mr. Duck ran 99 miles of primary traverse and set 11 permanent marks, and E. C. Bibbee and J. M. Ray ran 263 miles of primary levels and set 77 permanent bench marks.

*Missouri.*—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted \$2,500, which was met with an equal allotment by the United States Geological Survey. The resurvey of the Smithville quadrangle, in Clay, Platte, and Clinton counties, was completed by H. H. Hodgeson, J. B. Leavitt, and P. W. McMillen, the area mapped being 125 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Missouri portion of the Renault quadrangle, in Ste. Genevieve County, was begun by F. W. Hughes, the area mapped being 51 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Missouri portion of the Crystal City quadrangle in Jefferson County, Mr. McMillen, R. G. Clinite, and G. W. Lucas ran 109 miles of primary levels and established 38 permanent bench marks, and J. H. Wilson ran 36 miles of primary traverse and set 2 permanent marks.

In addition to the cooperative work in Missouri, the control of the Missouri portions of the Kimmswick, Chester, and Perryville quadrangles, in Jefferson and Perry counties, was begun by Mr. Wilson, 44 miles of primary traverse being run and 3 permanent bench marks set. The resurvey of the Sturgeon quadrangle, in Boone and Howard counties, was begun by W. J. Lloyd and P. W. McMillen, the area mapped being 76 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area and of the Moberly, Macon, Glasgow, Boonville, and Jefferson City quadrangles, in Audrain, Monroe, Randolph, Boone, Howard, Shelby, Macon, Saline, Cooper, and Chariton counties, Mr. McNair and Mr. Duck ran 144 miles of primary traverse and set 11 permanent marks, and Mr. McMillen and Mr. Bibbee ran 117 miles of primary levels and established 23 permanent bench marks.

*Ohio.*—The governor of Ohio allotted \$25,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted \$10,000. The survey of the Shiloh quadrangle and of the unmapped portions of the Coshocton, Gambier, Fredericktown, Marengo, Millersburg, Loudonville, Perrysville, Siam,



and Troy quadrangles, in Holmes, Coshocton, Knox, Licking, Marion, Delaware, Wayne, Ashland, Richland, Miami, Shelby, Champaign, Crawford, Huron, Seneca, and Clark counties, was completed; that of the Brinkhaven and Shauck quadrangles, in Holmes, Knox, Coshocton, Wayne, Richland, Morrow, and Crawford counties, was continued; and that of the Mount Gilead, Kenton, Bucyrus, and Larue quadrangles, in Morrow, Marion, Crawford, Logan, Wyandot, and Hardin counties, was begun. The total area mapped was 1,739 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. This work was done by J. H. Jennings, G. S. Smith, C. W. Goodlove, W. J. Lloyd, J. R. Eakin, Fred Graff, jr., Merrill Hackett, W. L. Miller, W. N. Vance, S. G. Lunde, A. P. Meade, J. A. Duck, L. L. Lee, A. J. Ogle, F. W. Hughes, J. L. Lewis, H. W. Peabody, O. G. Taylor, J. H. Wilson, N. E. Ballmer, W. S. S. Johnson, Horace Rayner, W. A. Reiter, C. R. French, W. S. Gehres, L. B. Glasgow, R. M. Herrington, L. H. Williams, and Howard Clark.

For the control of these areas and of the Alger quadrangle, in Hardin, Logan, Auglaize, and Allen counties, E. C. Bibbee and S. L. Parker ran 258 miles of primary levels and established 59 permanent bench marks.

*Ohio-Kentucky.*—The revision of culture in the East and West Cincinnati quadrangles, in Hamilton and Clermont counties, was completed, the area mapped being 463 square miles, for publication on the scale of 1:24,000, with a contour interval of 20 feet. This work was done by J. H. Jennings and N. E. Ballmer. Of the area mapped, 140 square miles was in Kentucky and 323 square miles in Ohio.

*Wisconsin.*—For the control of the La Farge, Kendall, Rapp, and Millston quadrangles, in Monroe and Vernon counties, A. D. Duck ran 97 miles of primary traverse and set 12 permanent marks, and L. F. Biggs ran 74 miles of primary levels and established 17 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Baldwin, Centralia, Macomb, Ottawa, and Gillespie, Ill.; Ames, Iowa; Hindman and Little Muddy, Ky.; Houghton and Grand Rapids, Mich.; Battle Lake, Deerwood, Dora, Perham, and Underwood, Minn.; Green City and Smithville, Mo.; Marengo, Fredericktown, Gambier, Loudonville, Perrysville, Roxabel, and Troy, Ohio; East and West Cincinnati, Ohio-Ky. (revision).

Progress in the drafting of additional sheets was made as follows: Chester, Ill.-Mo., 40 per cent; Vincennes, Ill.-Ind., 50 per cent; Sturgeon, Mo., 30 per cent; Brinkhaven, Ohio, 63 per cent; Coshocton, Ohio, 95 per cent; Millersburg, Ohio, 17 per cent; Mount Gilead, Ohio, 24 per cent; Shauck, Ohio, 43 per cent; Shiloh, Ohio, 8 per cent; Siam, Ohio, 70 per cent.

The following computations and adjustments were made:

Primary-level circuits in the Baldwin, Colchester, Edwardsville, Gillespie, Litchfield, Macomb, and New Douglas (Ill.), and Alton and Chester (Ill.-Mo.) quadrangles were adjusted. Geographic positions for the Avon, Dwight, Earlville, Elmwood, Galesburg, Glasford, Goodhope, Kings, Marseilles, Monmouth, Morris, Odell, Plano, Rochelle, and Yorkville (Ill.) and Edgington and Keithsburg (Ill.-Iowa) quadrangles were computed.

Primary-level circuits were adjusted and geographic positions were computed for the Ames, Boone, Ogden and Webster City quadrangles (Iowa). Geographic positions for the Durant, Jewell, and Nevada quadrangles (Iowa) were computed.

Primary-level circuits in the Goodloe, Hindman, Laynesville, and Virgie (Ky.) and Pound and Regina (Ky.-Va.) quadrangles were adjusted.

Primary-level circuits were adjusted and geographic positions were computed for the Aitkin, Brainerd, Crosslake, Deerwood, Emily, McGregor, Seavey, and Wealthwood quadrangles (Minn.). Primary-level circuits in the Barnesville, Fergus Falls, and Pelican Rapids quadrangles (Minn.) were adjusted and geographic positions for the Haypoint, Lastrup, Mae, Onamia, Opstead, and Rucker quadrangles (Minn.) were computed.

Primary-level circuits were adjusted and geographic positions were computed for the Glasgow and Sturgeon quadrangles (Mo.). Primary-level circuits in the Smithville (Mo.) and Kansas City and Leavenworth (Kans.-Mo.) quadrangles were adjusted and geographic positions for the Jefferson City and Moberly (Mo.) and Crystal City and Kimmswick (Mo.-Ill.) quadrangles were computed.

Primary-level circuits in the Sandusky, Shiloh, Siam, Springfield, Upper Sandusky, Waynesville, West Salem, and Xenia quadrangles (Ohio) were adjusted.

Primary-level circuits were adjusted and geographic positions were computed for the La Farge and Rapp quadrangles (Wis.). Primary-level circuits in the Winona quadrangle (Wis.-Minn.) were adjusted and geographic positions for the Millston, Shamrock, and Sparta quadrangles (Wis.) were computed.

#### ROCKY MOUNTAIN DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Colorado, Missouri, Montana, Nebraska, New Mexico, Oklahoma, and Wyoming. This work comprised the survey of 2 quadrangles, 1

mining district, and 1 Government reservation, and the resurvey of 2 quadrangles, in addition to which 14 quadrangles were partly surveyed and 1 quadrangle was partly resurveyed. The total new area mapped was 2,899 square miles, 1,584 square miles for publication on the scale of 1:125,000, 1,311 square miles for publication on the scale of 1:62,500, and 4 square miles for publication on the scale of 1:12,000. The area resurveyed was 1,185 square miles, 957 square miles for publication on the scale of 1:125,000, and 228 square miles for publication on the scale of 1:62,500. In connection with this work 523 miles of primary levels were run and 136 permanent bench marks were established. A river profile survey was made of a portion of one stream, covering a distance of 95 linear miles.

Primary traverse and primary triangulation were carried on at different times by three parties, the work extending over portions of Nebraska, New Mexico, and Wyoming. The total area covered by this primary control was about 8,175 square miles, of which 457 were controlled by primary traverse, 102 miles being run and 25 permanent marks being set. Thirty-four triangulation stations were occupied and 25 were marked. The results of this work made control available in 10 quadrangles.

Topographic surveys in Rocky Mountain division from July 1, 1912, to June 30, 1913.

State.	Contour interval.	For publication on the scale of—					Total area surveyed.	Primary levels.		Primary traverse.	
		1:125,000		1:62,500		1:12,000		Distance run.	Bench marks.	Distance run.	Per manent marks.
		New.	Resurvey.	New.	Resurvey.	New.					
	Feet.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Sq. mi.	Miles.		Miles.	
Colorado.....	50-100	493	.....	638	.....	.....	1,131	199	61	.....	.....
Missouri.....	10	.....	.....	134	.....	.....	134	.....	.....	.....	.....
Montana.....	50-100	694	.....	.....	.....	.....	694	96	24	.....	.....
Nebraska.....	200	.....	.....	217	.....	.....	217	58	15	102	25
New Mexico...	50	.....	.....	225	.....	.....	225	70	12	.....	.....
Oklahoma.....	50	397	957	.....	.....	.....	1,354	.....	.....	.....	.....
Wyoming.....	25	.....	.....	97	228	4	329	100	24	.....	.....
	.....	1,584	957	1,311	228	4	4,084	523	136	102	25

DETAILS OF WORK BY STATES.

Arkansas.—A special survey of the sewer system of Hot Springs, Ark., was made for the Department of the Interior under a provision of the sundry civil act approved August 24, 1912, the expenses of the work being borne equally by the department and the city of Hot Springs, as provided by the law.

*Colorado.*—The survey of the Axial, Monument Butte, and Soda Canyon quadrangles, in Moffat, Montezuma, and La Plata counties, was completed by R. W. Berry, Gilbert Young, R. H. Reineck, C. P. McKinley, and G. W. Lucas, the area mapped being 638 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these areas and of the Lay quadrangle, in Moffat County, Mr. McKinley, Mr. Lucas, and C. W. Rowell ran 86 miles of primary levels and established 24 permanent bench marks. The survey of the Chromo quadrangle, lying partly in the San Juan and Rio Grande national forests, in Archuleta, Conejos, Rio Grande, and Mineral counties, was continued and that of the Longs Peak and Creede quadrangles, lying partly in the San Juan Rio Grande, Colorado, Arapahoe, and Medicine Bow national forests, in Mineral, Rio Grande, Larimer, Grand, and Boulder counties, was begun by Basil Duke, B. A. Jenkins, S. T. Penick, C. P. McKinley, R. R. Monbeck, C. W. Rowell, and L. B. Glasgow, the total area mapped being 493 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, 379 square miles being in the national forests. For the control of these areas Mr. Rowell, C. A. Ecklund, and C. C. Holder ran 113 miles of primary levels and established 37 permanent bench marks.

*Colorado-Utah.*—The profile survey of Grand River was completed by R. C. Seitz. The total distance of the stream covered by the profile survey was 95 linear miles, in connection with which 156 miles were traversed. All of this season's work was in Grand and San Juan counties, Utah, the Colorado portion of the stream having been surveyed during the last season.

*Missouri.*—The survey of the Missouri portion of the Nemaha quadrangle, in Atchison County, was completed by B. A. Jenkins, the total area mapped being 134 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. The Nebraska portion of this quadrangle was mapped in cooperation with the State of Nebraska during the season of 1912.

*Montana.*—The survey of the Nyack quadrangle, lying partly in the Lewis and Clark and Blackfeet national forests, Flathead County, was completed, and that of the Marston quadrangle, in the Blackfeet National Forest, in Flathead and Lincoln counties, was begun by C. G. Anderson, C. J. Ballinger, Gilbert Young, and R. T. Evans, the total area mapped being 537 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, of which 522 square miles is in the national forests. The survey of the Plentywood quadrangle, in Valley County, was begun by A. B. Searle and L. B. Fees, the total area mapped being 157 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

For the control of these areas Mr. Fees and Mr. Ballinger ran 96 miles of primary levels and established 24 permanent bench marks. (See also p. 117.)

*Nebraska.*—The State geologist of Nebraska allotted \$2,000 for the continuation of the cooperative topographic surveys in that State during the years 1913 and 1914, to be met by the United States Geological Survey with an equal allotment. In order to take advantage of favorable weather the State money was made available for expenditure in April, 1913. The survey of the Falls City quadrangle, in Richardson County, was completed, and that of the Howe quadrangle, in Nemaha and Richardson counties, was begun by C. C. Gardner, R. H. Reineck, and R. R. Monbeck, the area mapped being 217 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Stella quadrangle, in Nemaha County, J. R. Ellis ran 102 miles of primary traverse and set 25 permanent marks, and Mr. Monbeck ran 58 miles of primary levels and set 15 permanent bench marks.

*New Mexico.*—The survey of the Raton quadrangle, in Colfax County, was completed, and that of the Brilliant quadrangle, in Colfax County, was begun by E. P. Davis and C. C. Holder, the total area mapped being 225 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area Mr. Holder ran 70 miles of primary levels and established 12 permanent bench marks. For the control of the Orogrande, Las Curnas, Gypsum Hills, and Las Cruces quadrangles, in Otero and Dona Ana counties, R. B. Robertson established 8 triangulation stations and permanently marked 3.

*Oklahoma.*—The director of the Oklahoma Geological Survey allotted \$1,000 for the continuation of cooperative topographic surveys in that State, and the Federal Survey allotted a like sum. The survey of the Hominy quadrangle, in Osage, Pawnee Creek, and Tulsa counties, was completed by Basil Duke, S. E. Taylor, C. P. McKinley, and C. W. Rowell, the total area mapped being 397 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. The cooperative funds being insufficient to cover the completion of the Hominy quadrangle, the additional expenses necessary for that purpose were borne by the Federal Survey.

In addition to the cooperative work in Oklahoma the resurvey of the Nowata quadrangle, in Nowata and Washington counties, was completed by Mr. Duke, Mr. Rowell, C. J. Ballinger, G. W. Lucas, and F. L. Whaley, the area mapped being 957 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

*Wyoming.*—The resurvey of the Hanna and Wolcott quadrangles, in Carbon County, was completed by J. H. Wilke and F. L. Whaley,

the area mapped being 228 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Ilo quadrangle, in Park and Bighorn counties, was begun by C. C. Gardner and R. R. Monbeck, the area mapped being 97 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas Mr. Monbeck and Mr. Whaley ran 100 miles of primary levels and established 24 permanent bench marks. For the control of the Rawlins, Baggs, Creston, and Sand Creek quadrangles, in Carbon and Sweetwater counties, C. B. Kendall occupied 26 triangulation stations and permanently marked 22. A special survey of the Owl Creek mining district, covering an area of 4 square miles in Hot Springs County, was made by R. W. Berry on the field scale of 1:12,000, with a contour interval of 10 feet, the work being desired for use in connection with geologic investigations.

#### OFFICE WORK.

The drafting of the following sheets was completed: Axial, Soda Canyon, Meeker, and Monument Butte, Colo.; Grand River, Colo.—Utah; Nyack, Mont.; Nemaha, Nebr.—Mo.; Raton, N. Mex.; Hominy, Nowata, and Vinita, Okla.; Gay Hill, Tex.; Hanna, Owl Creek mining district, and Walcott, Wyo.; Hot Springs sewers, Ark.

Progress in the drafting of additional sheets was made as follows: Chromo, Colo., 79 per cent; Longs Peak, Colo., 20 per cent; Marston, Mont., 40 per cent; Plentywood, Mont., 47 per cent; Falls City, Nebr., 14 per cent; Brilliant, N. Mex., 67 per cent; Ilo, Wyo., 42 per cent.

The following computations and adjustments were made:

Primary-level circuits in the Axial, Chromo, Monument Butte, and Soda Canyon quadrangles (Colo.) were adjusted. The field notes for a single-spur line in the Central City and Longs Peak quadrangles (Colo.) were checked.

Primary-level circuits in the Plentywood quadrangle (Mont.) were adjusted, and the field data for a spur line in the Kalispell and Marston quadrangles (Mont.) were checked.

Primary-level circuits were adjusted and geographic positions were computed for the Falls City and Howe quadrangles (Nebr.). Primary-level circuits in the Hiawatha quadrangle (Nebr.—Kans.) were adjusted, and geographic positions in the Stella quadrangle (Nebr.) were computed.

Primary-level circuits in the Brilliant, Koehler, and Mount Laughlin quadrangles (N. Mex.) were adjusted, and final geodetic distances and positions for the Alamogordo, Avis, Carrizozo, Gypsum Hills, Hondo, Las Cruces, Las Curnas, Mescalero, Orange, Orogrande, Ozanne, Tonuco, and Tularosa quadrangles (N. Mex.) were computed.



Primary-level circuits in the Claremore, Hominy, Newkirk, Pawnee, Pondcreek, and Washunga quadrangles (Okla.) were adjusted.

Primary-level circuits in the Bobbin and Navasota quadrangles (Tex.) were adjusted.

Primary-level circuits in the Almond, Aspen Mountains, Maxon, Rock Springs, South Bitter Creek, Table Mountain, and Walcott quadrangles (Wyo.) were adjusted, and the field notes for a spur line of primary levels in the Ferris, Ilo, Rawlins, and Rongis quadrangles (Wyo.) were checked. Geodetic distances and positions for the Baggs, Creston, Ferris, Frewen, Rawlins, and Sand Creek quadrangles (Wyo.) were computed.

#### PACIFIC DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Arizona (with a small area in New Mexico), California (with a small area in Nevada), and Utah. This work comprised the completion of the survey of 23 quadrangles, the partial survey of 11 quadrangles, the partial resurvey of 2 quadrangles, the revision of 1 special area, and the partial revision of 2 quadrangles. The total new area mapped was 8,534 square miles—3,123 square miles for publication on the scale of 1:250,000, 4,114 for publication on the scale of 1:125,000, 551 for publication on the scale of 1:62,500, and 746 for publication on the scale of 1:31,680. The area resurveyed was 80 square miles—71 for publication on the scale of 1:62,500, and 9 for publication on the scale of 1:31,680.

In connection with this work 649 miles of primary levels were run and 168 permanent bench marks were established. In addition profile surveys were made of three rivers, the distance traversed being 209 linear miles.

Primary triangulation was carried on in California by two parties. The total area covered by this primary control was about 2,065 square miles, 70 triangulation stations being occupied and 34 permanently marked. The results of this work made control available in 20 quadrangles.

Topographic surveys were made in the Territory of Hawaii covering portions of one island (Hawaii). The survey of one 15-minute quadrangle was completed and that of one 15-minute quadrangle was begun. The total area mapped was 153 square miles, for publication on the scale of 1:31,680, in connection with which 51 miles of primary and precise levels were run and 13 permanent bench marks were established. Primary triangulation and primary traverse were also carried on, 18 miles of primary traverse being run and 2 perma-

ment marks set and 6 triangulation stations being occupied and marked.

*Topographic surveys in Pacific division from July 1, 1912, to June 30, 1913.*

#### DETAILS OF WORK BY STATES.

**Arizona.**—The survey of the Arizona portion of the Douglas quadrangle, in Cochise County, was completed by Cornelius Schnurr and C. C. Holder, the area mapped being 169 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The survey of the unmapped portions of the Mesa and Maricopa quadrangles, in Maricopa and Pinal counties, was completed by T. P. Pendleton and D. H. Watson, the total new area mapped being 153 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. In connection with this work the culture was completely revised and brought up to date on the 346 square miles comprising the portions of these quadrangles previously mapped, for publication as a part of the completed surveys. The survey of the Benson quadrangle, lying partly in the Coronado and Garces national forests, in Pima and Cochise counties, and of the Arizona portion of the Hereford quadrangle, lying partly in the Garces National Forest, in Cochise County, was completed by H. W. Peabody, C. P. McKinley, Cornelius Schnurr, L. B. Glasgow, and C. C. Holder, the total area mapped being 1,324 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Douglas quadrangle Mr. Schnurr ran 45 miles of primary levels and established 10 permanent bench marks. (See below.)

**Arizona-New Mexico.**—The survey of the unmapped portion of the Boyles quadrangle, lying almost entirely in the Apache National Forest, in Greenlee County, Ariz., and in the Datil and Gila national forests, Socorro County, N. Mex., was completed by H. H. Hodgeson,

L. H. Williams, and R. R. Monbeck, the area mapped being 748 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area, 710 square miles lies in the national forests, of which 95 square miles is in New Mexico. For the control of this quadrangle Mr. Monbeck ran 96 miles of primary levels and established 24 permanent bench marks.

*California.*—The Department of Engineering of California allotted \$14,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum. The survey of the Salinas Valley was completed, the area mapped this year comprising 10 square miles in the valley portions of the San Ardo and Bradley quadrangles, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet. This work was done by Duncan Hannegan, Charles Hartman, jr., E. R. Bartlett, and H. S. Leicht. In the San Joaquin Valley the survey of the Union Island, Lathrop, Burnham, Banta, Vernalis, Manteca, Peters, Avena, Hospital Creek, Trigo, and Clyde 7½ minute quadrangles was completed and that of the Westley, Eugene, Oakdale, No. II, and Patterson quadrangles was begun by Mr. Hannegan, J. P. Harrison, H. W. Peabody, W. N. Vance, T. P. Pendleton, J. B. Leavitt, R. B. Kilgore, D. H. Watson, S. E. Taylor, L. V. Fees, F. A. Danforth, O. G. Taylor, R. M. LaFollette, C. A. Stonesifer, and Fred Rider, the total area mapped being 736 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet.

The resurvey of the valley portion of the Midway 7½-minute quadrangle (the northeast quarter of the Tesla 30-minute quadrangle) was completed by Mr. Hannegan, the area mapped being 9 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of the Tracy, Butlers, Modesto, Empire, Waterford, No. I, Coopertown, Sonora, No. III, Montpelier, Denair, Ceres, No. II, Westley, Hospital Creek, Patterson, Crows Landing, No. IV, Turlock, Cressy, No. V, Atwater, No. VIII, Stevinson, Gustine, Newman, Orestimba Creek, Crevison Peak, Las Garzas Creek, Ingomar, Salt Slough, Mariposa Slough, Deadman Creek, Berendo, Minturn, Chowchilla Slough, No. X, Elgin, Los Banos, and San Luis Creek 7½-minute quadrangles, C. F. Urquhart, assisted by W. R. Chenoweth and R. B. Kilgore, occupied 43 triangulation stations and permanently marked 12, and D. S. Birkett ran 300 miles of primary levels and established 82 permanent bench marks. In order to extend triangulation into the valley Mr. Urquhart occupied and marked 17 triangulation stations in the Mount Boardman, Gilroy Hot Springs, Morgan Hill, Hamilton, Tesla, Hollister, Pajaro, New Almaden, and Capitola quadrangles.

In addition to the regular cooperative surveys in California the State Board of Control (Water Power) allotted \$1,100, in addition

to that reported last year, for the completion of profile surveys of Pit River and the Middle Fork of American River and \$2,500 for a profile survey of San Joaquin River, the United States Geological Survey making no allotment for the field survey but detailing its men to carry on the work and publishing the completed sheets. These river-profile surveys were completed by J. G. Staack, J. P. Harrison, and T. P. Pendleton, the total distance traversed being 209 linear miles, in Placer, Eldorado, Shasta, Lassen, Madera, and Fresno counties.

In addition to the cooperative work in California, the survey of the Petaluma, Capitola, and Soledad quadrangles, in Marin, Sonoma, Santa Cruz, and Monterey counties, was completed by J. P. Harrison, J. B. Leavitt, W. S. S. Johnson, O. G. Taylor, F. A. Danforth, R. M. La Follette, and C. A. Stonesifer, the total area mapped being 229 square miles, for publication on the scale of 1:62,500, with contour intervals of 25 and 50 feet. The survey of the Priest Valley quadrangle, lying partly in the Monterey National Forest, in Monterey, Fresno, and San Benito counties; of the Mount Morrison quadrangle, lying partly in the Sequoia National Forest, in Inyo, Mono, and Fresno counties; and of the Mohave quadrangle, lying partly in the Sequoia National Forest, in Kern County, was completed by J. G. Staack, B. A. Jenkins, W. N. Vance, S. E. Taylor, H. S. Leicht, T. P. Pendleton, F. A. Danforth, C. W. Wardle, R. M. La Follette, J. W. Muller, and C. A. Stonesifer, the total area mapped being 1,837 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of the area mapped, 822 square miles lies within the national forests, of which 7 square miles extends into Nevada. For the control of the Mount Morrison quadrangle Mr. Wardle ran 66 miles of primary levels and established 17 permanent bench marks. The survey of the Seiad quadrangle, in the Klamath National Forest, in Siskiyou County, was begun by J. W. Muller and H. S. Leicht, the area mapped being 170 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Borax Flat quadrangle, lying partly in the Sequoia National Forest, in San Bernardino and Kern counties, was completed; that of the Sawyers Bar quadrangles, in the Trinity national forests, in Trinity, Siskiyou, and Humboldt counties, was continued; and that of the Crucero quadrangle, in San Bernardino and Inyo counties, was begun, the total area mapped being 3,158 square miles, 3,123 for publication on the scale of 1:250,000, with contour intervals of 100 and 200 feet, and 35 for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of the area mapped, 333 square miles lies in the national forests. This work was done by J. E. Blackburn, S. G. Lunde, J. P. Harrison, C. W. Wardle, L. V.

Fees, and H. L. McDonald. For the control of the Borax Flat and Crucero quadrangles, Mr. Urquhart and Mr. Chenoweth occupied 20 and marked 5 triangulation stations, and Mr. Fees and Mr. Wardle ran 111 miles of primary levels and established 27 permanent bench marks.

The map of the Kern River oil field (formerly published as the Oil Center special) was completely revised by Duncan Hannegan, the area revised covering 30 square miles in Kern County, for publication on the scale of 1:12,000, with a contour interval of 20 feet.

*Nevada.*—(See pp. 110, 113.)

*Utah.*—The resurvey of the Wellington quadrangle (the south-east quarter of the northwest quarter of the Price River 1-degree quadrangle) was begun by E. R. Bartlett and L. B. Glasgow, the total area mapped being 71 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this quadrangle Mr. Glasgow ran 31 miles of primary levels and established 8 permanent bench marks.

*Hawaii.*—Cooperative topographic surveys were continued in the Hawaiian Islands, under an arrangement similar to that of the previous fiscal year, the Territory allotting \$15,000 and the United States Geological Survey allotting \$5,000. In the spring of 1913 the Territory allotted \$200 additional for cooperative surveys. The survey of the island of Hawaii was continued, the area mapped being 153 square miles, for publication on the scale of 1:31,680, with contour intervals of 10 and 50 feet. This work covered portions of the Honomu and Hilo 15-minute quadrangles and was done by C. H. Birdseye, A. T. Fowler, A. O. Burkland, J. M. Rawls, and S. H. Birdseye. For the control of these areas C. H. Birdseye and Mr. Burkland occupied and marked 6 triangulation stations, Mr. Fowler ran 18 miles of primary traverse and set 2 permanent marks, and S. H. Birdseye ran 51 miles of primary and precise levels and established 13 permanent bench marks. As it is planned to begin during the next fiscal year the topographic mapping of the island of Oahu, tracings were made of data acquired by the War Department for the preparation of the map of the entire island on the scale of 1:48,000, with a contour interval of 40 feet.

#### OFFICE WORK.

The drafting of the following sheets was completed: Phoenix (revision), Benson, Boyles, and Douglas, Ariz.; American River, Avena, Caliente, Capitola, Feather River, Lathrop, Midway, Burnham, Mount Morrison, Monterey, Manteca, Kern River oil field (revision), Petaluma, Peters, Pit River, Priest Valley, Vernalis, San Joaquin River, Tracy, Tuolumne River, and Union Island, Cal.; Hamakua, Hawaii.

Progress in drafting of additional sheets was made as follows: Hereford, Ariz., 90 per cent; Maricopa, Ariz., 60 per cent; Bradley, Cal., 9 per cent; Borax Flat, Cal., 32 per cent; Crucero, Cal., 23 per cent; Kings City, Cal., 38 per cent; Metz, Cal., 20 per cent; Mojave, Cal., 56 per cent; San Ardo, Cal., 12 per cent; Soledad, Cal., 85 per cent; Honomu, Hawaii, 98 per cent; Waipio, Hawaii, 61 per cent; Kohala, Hawaii, 60 per cent; Wellington, Utah, 28 per cent.

The following computations and adjustments were made:

Primary-level circuits in the Clifton (Ariz.) and the Boyles (Ariz.-N. Mex.) quadrangles were adjusted.

Primary-level circuits in the Butlers, Ceres, Chowchilla Slough, Cooperstown, Cressy, Crows Landing, Deadman Creek, Denair, Dry Creek, Elgin, Empire, Gustine, Hospital Creek, Ingomar, Los Banos, Madera, Mariposa Slough, Newman, Modesto, Montpelier, Nos. I, II, III, IV, V, VIII, and X, Owens Creek, Patterson, Salt Slough, Stevinson, Turlock, Vernalis, Volta, Waterford, Westley, and three unnamed 7½-minute quadrangles and the Sonora 30-minute quadrangle (Cal.) were adjusted. A preliminary adjustment was made of level circuits in the Mount Morrison (Cal.) and White Mountain (Cal.-Nev.) quadrangles.

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Hilo and Honomu quadrangles (Hawaii). Primary-level circuits in the Hamakua, Kilauea Crater, Kohala, Puna, and Waipio quadrangles (Hawaii) were adjusted.

Primary-level circuits in the Kyune, Ninemile Creek, and Wellington quadrangles (Utah) were adjusted.

#### NORTHWESTERN DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Idaho (with small areas extending into Montana and Wyoming), Oregon, and Washington. This work comprised the completion of the survey of 7 quadrangles and the partial survey of 15 quadrangles. The total new area mapped was 2,118 square miles, 99 square miles for publication on the scale of 1:31,680, 739 square miles for publication on the scale of 1:62,500, and 1,280 square miles for publication on the scale of 1:125,000.

In connection with this work 736 miles of primary levels were run and 224 permanent bench marks were established. In addition, profile surveys were made of 11 rivers, the distance traversed being 580 linear miles, in connection with which 23 square miles were surveyed for publication on the scale of 1:31,680.



Primary triangulation and primary traverse were carried on at different times by four parties, the work being distributed over portions of Idaho, Montana, Oregon, and Washington. The total area covered by this primary control was about 5,460 square miles, of which 1,100 square miles were controlled by primary traverse, 233 miles being run and 53 permanent marks set. Thirty-six triangulation stations were occupied and permanently marked. The result of this work was to make control available in 18 quadrangles.

*Topographic surveys in northwestern division from July 1, 1912, to June 30, 1913.*



#### DETAILS OF WORK BY STATES.

*Idaho.*—The survey of the Lanes Creek quadrangle (formerly called Wayan) and of the Crow Creek quadrangle (formerly called Preuss Range) was completed; that of the Freedom and Henry quadrangles was continued; and that of the southeast quarter of the Ammon 30-minute quadrangle and of the southwest quarter of the Irwin 30-minute quadrangle was begun, the total area mapped being 250 square miles in Bannock County, Idaho, and 56 square miles in Uinta County, Wyo., for publication on the scale of 1:62,500, with a contour interval of 50 feet, field work on 69 square miles being done on a scale of 1:31,680. This work was done by Albert Pike, J. L. Lewis, and F. A. Danforth. For the control of these quadrangles Mr. Danforth ran 46 miles of primary levels and established 14 permanent bench marks, and W. R. Chenoweth occupied 2 triangulation stations and marked 9.

A profile survey of Salmon River from the mouth of Little Salmon River to Snake River, in Idaho and Nez Perce counties, was completed by O. G. Taylor, the distance covered being 87 linear miles.

The State engineer of Idaho, from a fund subscribed by private parties, allotted \$700 for a profile survey of Snake River, which was met by the Federal Survey with a like sum. The cooperative allot-

ments were not sufficient to complete the survey, and the additional expenses necessary were borne by the Federal Survey. The profile survey covered a section of the river 242 miles in length from Minidoka Dam to Warm Springs Ferry, in Cassia, Lincoln, Twin Falls, and Owyhee counties, and 52 miles of additional traverse were run in connection with the river survey. The work was done by A. T. Fowler and A. J. Ogle.

*Idaho-Montana.*—The survey of the Taff quadrangle, in the Cœur d'Alene National Forest, in Shoshone County, Idaho, and Missoula County, Mont., was continued by J. E. Blackburn, the area mapped being 127 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 27 square miles lies in Idaho and 100 square miles in Montana. For the control of the Salmon, Gibbons Pass, Trappers Peak, Watchtower Peak, Sapphire, Hamilton, and Noble quadrangles, in Lemhi County, Idaho, and Ravalli County, Mont., T. M. Bannon occupied 11 and marked 13 triangulation stations, of which 5 stations were occupied and 6 were marked in Idaho. For the control of these areas and the May, Rabbit Foot, Bay Horse, Dickey, Mackay, Argo, Tilden, and Shelley quadrangles, in Lemhi, Custer, Blaine, and Bingham counties, Idaho, D. S. Birkett ran 210 miles primary levels and established 71 permanent bench marks.

*Oregon.*—The State engineer of Oregon allotted \$15,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted a like sum. The survey of the Willamette Valley was continued and resulted in the partial mapping of the Albany and Corvallis quadrangles, in Linn, Marion, and Benton counties, the total area mapped being 76 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. This work was done by J. H. Wheat, R. L. Harrison, and W. S. S. Johnson. The survey of the unmapped portions of the Oregon City and Boring quadrangles, in Clackamas, Multnomah, and Washington counties, was completed by Mr. Wheat, A. E. Murlin, L. R. Ebert, and Cornelius Schnurr, the total area mapped being 51 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Oregon portion of the Arlington quadrangle, in Gilliam County, was begun by Oscar Jones and Mr. Ebert, the area mapped comprising 343 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of this quadrangle J. R. Ellis occupied 9 triangulation stations and permanently marked 7, and Mr. Ebert and Mr. Watson ran 51 miles of primary levels and established 14 permanent bench marks. For the control of the Condon quadrangle, in Gilliam and Wheeler counties, Mr. Ellis occupied and marked 2 triangulation stations. The survey of the Oregon portion of the Pine quad-

range, in Baker County, was completed by Glenn S. Smith, S. G. Lunde, and Howard Clark, the area mapped being 236 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The survey of the Idaho portion of this quadrangle, covering 105 square miles in Washington County, was completed by Mr. Lunde for publication on the same scale, all expenses being borne by the Federal Survey.

In addition to the regular cooperative work in Oregon a profile survey of Deschutes River was made in connection with water-power investigations being carried on by the water-resources branch of the Federal Survey in cooperation with the State of Oregon. All expenses of the profile survey were paid by the State, the work being done by members of the topographic branch. The distance traversed was 36 linear miles in Crook County, in connection with which four power sites were surveyed, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet.

In addition to the cooperative work in Oregon the survey of the Cazadero 30-minute quadrangle, in Clackamas County (the north-west quarter of which was mapped in cooperation as the Boring 15-minute quadrangle) was continued by Mr. Murlin, Mr. Lunde, Mr. Schnurr, F. W. Crisp, and W. G. Carson, the area mapped being 224 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet.

*Washington.*—The Board of Geological Survey of Washington allotted \$13,750 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted a like sum. The survey of the Malaga and Hoquiam quadrangles, in Douglas, Grant, and Chehalis counties, was completed; that of the Wenatchee quadrangle, in Chelan County, was continued; and that of the Ocosta, Mitchell, and Haven quadrangles, in Chehalis, Grant, Benton, and Yakima counties, was begun, the total area mapped being 382 square miles, for publication on the scale of 1:62,500, with contour intervals of 25 and 50 feet. The survey of the Chehalis quadrangle, in Thurston, Pierce, and Lewis counties, and of the Washington portion of the Arlington quadrangle, in Klickitat County (the Oregon portion of which is being mapped in cooperation with that State), was begun, the area mapped being 195 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. This work was done by A. E. Murlin, C. L. Sadler, W. O. Tufts, Charles Hartman, jr., H. L. McDonald, A. J. Ogle, O. G. Taylor, R. B. Kilgore, L. V. Fees, D. H. Watson, and C. H. King, jr. For the control of these areas and of the Gate, Olympia, Anderson, Tacoma, Pasco, Fordnah, and Beverly quadrangles, in Thurston, Pierce, Franklin, and Grant counties, C. F. Urquhart occupied 12 and marked 5 tri-

angulation stations; L. F. Biggs, J. R. Ellis, and W. B. Godfrey ran 233 miles of primary traverse and set 53 permanent marks; and E. M. Bandli, D. S. Birkett, and R. I. Thomas ran 368 miles of primary levels and established 105 permanent bench marks.

The profile surveys of Wenatchee, Chelan, Stehekin, and Methow rivers and of Railroad Creek were made by W. O. Tufts and A. J. Ogle, the distance traversed being 81 linear miles, in Chelan and Okanogan counties. In connection with this work reservoir sites covering 13 square miles were surveyed, for publication on the scale of 1:31,680, with contour intervals of 5, 10, and 25 feet, and 71 miles of additional traverse were run.

In addition to the cooperative work in Washington, the survey of the Mount St. Helens quadrangle, in the Columbia National Forest, in Cowlitz, Skamania, and Lewis counties, was begun by Albert Pike, the area mapped being 50 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area and of the Kalama quadrangle (Oreg.-Wash.) E. M. Bandli ran 61 miles of primary levels and established 20 permanent bench marks.

Profile surveys of Pend Oreille and Spokane rivers were made by A. P. Meade, the Pend Oreille River survey covering 70 linear miles in Pend Oreille County, Wash., and 7 linear miles in Bonner County, Idaho, and the Spokane River survey covering 34 linear miles in Lincoln and Stevens counties, Wash. In connection with this work, 27 miles of additional traverse were run.

A special profile and reservoir-site survey of San Poil River, in the Colville Indian Reservation, Perry County, was made for the Department of the Interior, all expenses being paid by the department from the appropriation for irrigation surveys of Indian reservations. This work covered 23 linear miles of river traverse, in connection with which reservoir sites covering an area of 10 square miles were mapped, for publication on the scale of 1:31,680, with a contour interval of 10 feet.

#### OFFICE WORK.

The drafting of the following sheets was completed: Lanes Creek, Salmon and Snake River, Idaho; Crow Creek, Idaho-Wyo.; Boring, Metolius River, and Oregon City, Oreg.; Pine, Oreg.-Idaho; Chelan River, Malaga, Methow River, Spokane River, and Wenatchee River, Wash.; Clark Fork, Wash.-Idaho.

Progress in the drafting of additional sheets was made as follows: Henry, Idaho, 40 per cent; Taff, Idaho-Mont., 43 per cent; Freedom, Idaho-Wyo., 30 per cent; Albany, Oreg., 64 per cent; Corvallis, Oreg., 13 per cent; Cazadero, Oreg., 62 per cent; Arlington, Oreg.-Wash., 40 per cent; and Wenatchee, Wash., 26 per cent.

The following computations and adjustments were made:

The field notes for a single-spur line and a circuit of primary levels dependent on it in the Ammon, Henry, and Lanes Creek quadrangles (Idaho) were checked. A preliminary adjustment was made of the prism-level line in the Argo, Bay Horse, Dickey, Mackay, Rabbit Foot, Shelley, and Tilden (Idaho), and May and Salmon (Idaho-Mont.) quadrangles. Preliminary computations of geodetic distances and positions for the Ammon, Hatch, Henry, Soda Springs, and Vinegar Hill (Idaho), and Gibbons Pass, Salmon, Trappers Peak, and Watchtower Peak (Idaho-Mont.) quadrangles were made.

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Arlington quadrangle (Oreg.-Wash.). Geodetic distances and positions for the Moro (Oreg.) and Goldendale (Oreg.-Wash) quadrangles were computed.

Primary-level circuits were adjusted and geodetic distances and positions were computed for the Chelan and Malaga quadrangles (Wash.). Primary-level circuits were adjusted and geographic positions were computed for the Anderson, Chehalis, Gate, Olympia, and Tacoma (Wash.) and Kalama (Wash.-Oreg.) quadrangles. Primary-level circuits in the Eatonville quadrangle (Wash.) were adjusted and geodetic distances and positions for the Wenatchee quadrangle (Wash.) were computed.

#### INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

J. H. Renshawe and W. M. Beaman inspected the field parties in Washington, D. C., and vicinity during portions of July and August. Mr. Renshawe spent September and October in inspecting the work of various field parties in the Atlantic and Central divisions. Mr. Beaman was engaged during September, October, November, and a portion of December in visiting river-survey and regular topographic parties in the Rocky Mountain, Northwestern, and Pacific divisions.

The office duties of Messrs. Renshawe and Beaman involved careful supervision of the inking and preparation of the final drawings of the topographic branch and their examination prior to submission for engraving. Mr. Beaman's duties also included the examination of river surveys and other sheets preparatory for photolithography and the examination and transmission of land classification, woodland, and other special information; attention to referred matters, largely from the editor of topographic maps; and the proper transmission of all original topographic map manuscript.

#### INSTRUMENTS AND TOPOGRAPHIC RECORDS.

As in past years the repairs of all topographic instruments were made under the supervision of E. M. Douglas, who also has charge of the topographic records.

One transit, one 20-inch Y level, and one telescopic alidade were purchased during the year.

In the Survey instrument shop Ernest Kübel and William Hohnhaus, expert mechanics, were employed during the entire year. Work was done not only for the topographic branch, but for other branches of the Survey, for the Reclamation Service, and for the General Land Office, the topographic branch being reimbursed by transfer of funds for all work not done for it.

The principal instruments repaired consisted of 174 telescopic alidades, 39 Y levels, 10 transits, 6 theodolites, 22 Locke levels, 241 box compasses, and 45 pocket compasses; repairs, alterations, or renewals were made to nearly 2,600 other articles.

A new device was designed and constructed for testing the accuracy of the position of box compasses on alidade rulers, the use of the Baldwin solar chart necessitating greater care in their alinement than heretofore.

The only repairs of consequence to topographic instruments made outside of the Survey shop were for leveling rods and aneroid barometers, no facilities at present being provided for any but minor repairs to such articles.

Special apparatus is provided for testing and magnetizing compasses and a record is kept of each compass, so that needles which prove defective can be replaced. All aneroid barometers are tested before they are sent out, it having been found that even new instruments are often in need of adjustment.

The economy and advantage of having instruments repaired in a shop under the Survey control are so great that it is hoped to increase the facilities for such work as soon as space is available.

The additions to the topographic records consisted of 188 triangulation and primary traverse books, 181 level books, not including the rodman's books, to which were given duplicate numbers, 337 vertical-angle or stadia books, 40 plane-table sheets, and 60 miscellaneous manuscript maps, all of which have been numbered and catalogued. About 50 chainman's notebooks were filed.

The fire in the Survey office on the afternoon of May 18 damaged about 3,500 field record books, and 2,500 pounds of the damaged books have since been delivered to the contractor for the purchase of waste paper. The loss or damage by this fire to instruments was very slight.

#### MAP OF THE UNITED STATES.

Of the work in progress last year on the 1:1,000,000 scale map of the United States under the direction of A. F. Hassan, base maps of the following sheets and international sheets have been completed:



Arkansas (portions of sheets I and J 15 and 16), Maryland (portions of sheets J 17 and 18), South Carolina (portion of sheet I 17), Montana (portions of sheets L and M 11, 12, and 13), and sheets I and J 10 of California, including 50 per cent of the relief.

Additional work includes the completion of the portions of North and South Dakota and Nebraska west of longitude 102 (sheets K, L, and M 13), 25 per cent of Oregon (sheets K and L 10 and 11), and 75 per cent of Virginia, West Virginia, and Kentucky (sheets J 16, 17, and 18), and the adjustment of the township lines in Missouri (sheets J 15 and 16 and K 15), and Utah (sheets J and K 12). The base maps of sheets I 17 and L 13 are completed.

### **WATER-RESOURCES BRANCH.**

#### **ORGANIZATION AND SCOPE OF WORK.**

The water-resources branch includes three divisions—surface water, ground water, and water utilization—each division being appropriately subdivided into sections for field work. The organization of the branch was as follows:

Chief of branch, M. O. Leighton, chief hydrographer, until June 3, 1913; N. C. Grover, chief hydraulic engineer, after June 3, 1913.

Division of surface water, John C. Hoyt, engineer, in charge.

Division of ground water, O. E. Meinzer, assistant geologist, in charge.

Division of water utilization, M. O. Leighton, chief hydrographer, in charge until June 3, 1913; N. C. Grover, chief hydraulic engineer, in charge after June 3, 1913.

With the change in chief of branch the title has been changed from chief hydrographer to chief hydraulic engineer, which is more closely in accord with the designation used in commercial organizations for men engaged in similar work and is also better descriptive of the qualifications for and duties of the office, as well as more distinctive, inasmuch as the Hydrographic Office of the Navy Department has better claim to the title of hydrographer.

The appropriation (\$150,000) of Federal funds has remained the same as in the preceding year, but the cooperative funds made available by allotments by States have been increased in some States and decreased in others, making necessary corresponding adjustments of the work. The hydrometric investigations made under the Weeks Act in the White Mountain area in New Hampshire have been completed.

## ALLOTMENTS.

The allotments of the appropriation for the fiscal year were as follows:

*Allotments of appropriation for investigation of water resources, 1912-13.*

Administrative expenses of the Survey-----	\$12, 444
Clerical assistance-----	4, 440
Computations, reports, and inspection-----	15, 500
Stream gaging in—	
New England and New York-----	5, 500
Southeastern States-----	4, 000
Ohio Valley-----	7, 500
Minnesota, Wisconsin, and North Dakota-----	6, 000
Colorado and Wyoming-----	9, 700
Montana -----	7, 000
Utah -----	3, 600
Idaho -----	7, 500
Oregon -----	5, 600
Washington -----	4, 000
California -----	5, 000
Arizona -----	3, 000
Hawaii-----	5, 000
Investigation of ground waters, including quality of waters--	16, 870
Land-classification board-----	12, 500
Water-power investigations-----	11, 846
Deschutes River investigations-----	3, 000
	<hr/>
	150, 000

## COOPERATION.

## STATES.

The cooperative funds made available by several States were as follows:

*Amounts allotted by States for cooperative work with United States Geological Survey in investigation of water resources.*

Arizona -----	\$3, 000
California :	
State engineer-----	\$9, 000
Conservation commission-----	12, 466
Board of control-----	7, 140
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	28, 586
Connecticut-----	1, 000
Hawaii-----	20, 000
Idaho -----	5, 000
Massachusetts -----	3, 000
Minnesota -----	3, 650
Montana -----	2, 500
Nevada-----	385
New York :	
State engineer-----	\$1, 500
Conservation commission-----	10, 000
	<hr/>
	11, 500

New Mexico.....	\$14, 174
Oregon.....	7, 470
Utah.....	2, 000
Vermont.....	1, 000
Washington.....	4, 200
West Virginia .....	132
Wyoming.....	265

The work performed under the cooperative agreements in the several States has been limited to stream gaging, except as follows:

*California.*—A large amount of stream-gaging work has been done in California, and investigations of ground-waters in the Sacramento and Santa Clara valleys have been made and are still in progress. Reports containing the results of hydrometric investigations within the State have been prepared and published.

*Hawaii.*—The cooperative work in Hawaii has included the measurement of precipitation and studies of water losses in irrigation canals, in addition to the stream-gaging work.

*Minnesota.*—A small amount of work in the surveying of river profiles in Minnesota has been accomplished. The measurement of stream flow has been continued throughout the year.

*Oregon.*—The survey of Deschutes River, in Oregon, to determine the possibilities of developing power on it has resulted in the preparation of special topographic maps of the river valley and of profiles of the river surface. A special report on the water supply and power possibilities of the stream has been practically completed and is proposed for publication in the near future. A large amount of stream-gaging work has been carried on throughout the year. The investigation of the chemical composition of the river waters of the State, to which reference was made in the report for the fiscal year ending June 30, 1912, to determine their utility in municipal, agricultural, and manufacturing uses, has been completed and a report thereon is now in preparation.

#### RECLAMATION SERVICE.

The Survey has maintained gaging stations at the expense of the reclamation fund and under the general direction of the Reclamation Service. These gaging stations are located on streams which are relied on to furnish water to reclamation projects under construction by that service. The field work of stream gaging is done by the Survey engineers who are engaged in such work in the locality, and payment is made by the Reclamation Service through a transfer of funds in the Treasury Department covering the actual cost of the investigations.

## OFFICE OF INDIAN AFFAIRS.

Investigations and reports have been made by the water-resources branch at the request of the Commissioner of Indian Affairs in connection with the classification of lands within Indian reservations with regard to water-power and reservoir sites, as follows:

*Crow Reservation.*—An investigation of the power-site and reservoir possibilities of the Crow Reservation was made under authority dated July 1, 1912. The report was filed on August 12, 1912.

*Flathead Reservation.*—Under authority dated January 24, 1913, an investigation of the power-site and reservoir possibilities on the Flathead Reservation has been made, but report thereon has not been filed.

*Klamath Reservation.*—A progress report on the power-site and reservoir possibilities of the Klamath Reservation, investigation of which was authorized October 12, 1911, was made on November 21, 1912. The final report has not yet been filed.

*Moki and Navajo reservations.*—A continuation of the investigation of the occurrence and availability of underground waters in the Moki and Navajo reservations was authorized April 11, 1913, and money was made available therefor, to be expended in part prior to July 1, 1913, and in part after that date. The field work on this investigation is in progress at the end of the fiscal year.

*Warm Springs Reservation.*—The investigation of the power-site and reservoir possibilities of the Warm Springs Reservation, authorized March 16, 1912, which had not been completed at the end of the last fiscal year, has now been finished, and a report thereon was filed on August 13, 1912.

*Yakima Reservation.*—Under date of September 5, 1912, an investigation of the power-site and reservoir possibilities of the Yakima Reservation was authorized, and field work thereon has been completed, but the report has not been finished at the end of the fiscal year.

*Stream gaging.*—Stream-gaging work has been continued in the following Indian reservations in accordance with authorizations of the Indian Office: Colville, Crow, Fort Hall, Klamath, Menominee, Pine Ridge, Queniult, Rosebud, Standing Rock, Warm Springs, and Yakima.

## PUBLICATIONS.

The work of the water-resources branch is represented by the following publications issued during the year: Water-Supply Papers 259, 281, 283, 284, 289 to 294, inclusive, 296 to 301, inclusive, 304, 305, 310, 311, 313 to 317, inclusive. Titles and brief summaries of these publications are given on pages 23–26. Water-Supply Papers 303,

307, 308, 317, 319, and 320 were at the Government Printing Office at the close of the year. Nine manuscripts were in the section of texts, ready for the printer, six were in hand awaiting editorial work, and 26 reports were in various stages of preparation. Reprints of Water-Supply Papers 255 and 295, the original editions of which had been exhausted, were delivered during the year.

#### DIVISION OF SURFACE WATERS.

##### ORGANIZATION.

The work of the division of surface waters, consisting primarily of the measurement of the flow of rivers, is carried on through the offices of the 12 districts into which the United States, including Alaska and Hawaii, has been divided for the purposes of efficient administration of the field work.

Each district office is under the supervision of a district engineer and is manned with a corps of assistants. The following list gives the districts, the name of the district engineer, and the location of the district office.

North Atlantic district: C. C. Covert, district engineer, Federal Building, Albany, N. Y.

Middle Atlantic district: G. C. Stevens, Washington, D. C.

South Atlantic and eastern Gulf district: Warren E. Hall, district engineer, Federal Building, Atlanta, Ga.

Ohio Valley district: A. H. Horton, district engineer, Federal Building, Newport, Ky.

Upper Mississippi River district: W. G. Hoyt, district engineer, Old Capitol Building, St. Paul, Minn.

Upper Missouri district: W. A. Lamb, district engineer, Montana National Bank Building, Helena, Mont.

Rocky Mountain district: Robert Follansbee, district engineer, Chamber of Commerce Building, Denver, Colo. Suboffice: G. A. Gray, assistant engineer, Capitol Building, Santa Fe, N. Mex.

Great Basin district: E. A. Porter, district engineer, Federal Building, Salt Lake City, Utah.

Idaho district: G. C. Baldwin, district engineer, Idaho Building, Boise, Idaho.

Northern Pacific coast district: Fred F. Henshaw, district engineer, Couch Building, Portland, Oreg. Suboffice: G. L. Parker, assistant engineer, Federal Building, Tacoma, Wash.

Southern Pacific district: H. D. McGlashan, district engineer, Customhouse, San Francisco, Cal. Suboffice: Federal Building, Los Angeles, Cal.

Hawaiian district: G. K. Larrison, Kapiolani Building, Honolulu, Hawaii.

Alaskan district: C. E. Ellsworth, district engineer.

##### CHARACTER AND METHODS OF WORK.

From the district offices field investigations incident to the work are made, and the results are sufficiently analyzed to insure that they are both accurate and complete. Places known as gaging stations are selected for making the regular measurements of discharge of

streams and for collecting sufficient data for determining the daily flow. At the end of the year 1,148 such stations were maintained, exclusive of those in Alaska and Hawaii. During the year 338 stations were discontinued and 261 stations established. In addition records ready for publication were received for about 240 stations from other Government bureaus and private persons. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or private persons.

The following table shows the distribution of the stations and measurements by States and also indicates the number of stations maintained by various cooperating parties:



*Geyser stations and cooperating parties, June 30, 1913.*



In order to maintain a high standard of work and to insure uniform methods in the several offices, regular inspection work is carried on from the Washington office. Each of the main district offices is annually visited and inspected. The methods that have been developed in the several districts are correlated and the efficiency of the work as a whole is thereby increased and the standards raised.

The data collected by the district offices are transmitted to the Washington office, where they are reviewed and prepared for publication in the computing section. The work of this section is important, as its examination of the records insures that the data presented to the public shall be prepared for publication with standard accuracy and in similar form. In the computing section many special hydraulic studies are also carried on, the results of which are published from time to time.

PUBLICATIONS.

The results of the work of the division of surface waters are published in the series of water-supply papers. These reports may be divided into two class—reports containing data in regard to stream flow, known as the progress reports of stream gaging, and special reports covering various subjects.

For convenience in publication and use of the data, the progress reports have been divided into 12 parts, as shown in the following list. Each part covers the same area from year to year. Special reports have been published as indicated in the list given on pages 125–126.

*Reports on surface-water supply of the United States.*

[The numbers given are the serial numbers of the water-supply papers.]

	1909	1910	1911	1912
North Atlantic coast.....	261	281	301	321
South Atlantic coast and eastern Gulf of Mexico.....	262	282	302	322
Ohio River basin.....	263	283	303	323
St. Lawrence River basin.....	264	284	304	324
Upper Mississippi River and Hudson Bay basins.....	265	285	305	325
Missouri River basin.....	266	286	306	326
Lower Mississippi River basin.....	267	287	307	327
Western Gulf of Mexico.....	268	288	308	328
Colorado River basin.....	269	289	309	329
Great Basin.....	270	290	310	330
California.....	271	291	311	331
North Pacific coast.....	272	292	312	332

Among the special reports are the following:

1. Three gazetteers covering the State of California and three volumes containing summaries of stream-flow data collected in that State, which were prepared in cooperation with the State (Water-Supply Papers 295–300).
2. A special report containing all available data collected in Minnesota, which was prepared and published by the State Drainage Commission.

3. A report covering the last two years' work in Idaho, which was prepared and published by the State engineer of Idaho.

4. A report on the flood of 1913 in the Ohio River drainage basin, which will be published as Water-Supply Paper 334.

#### DIVISION OF UNDERGROUND WATERS.

##### ORGANIZATION.

At the beginning of the fiscal year O. E. Meinzer was placed in charge of the division of underground waters, to succeed W. C. Mendenhall, whose resignation was made necessary by his duties as chief of the land-classification board. Mr. Mendenhall, however, retains advisory relation to the division. As in previous years, R. B. Dole has had supervision of the chemical investigations.

##### ALLOTMENTS AND OUTLINE OF WORK.

The allotment for the work of the division was \$16,870. Of this amount, \$11,720 was used for investigations of underground-water problems and \$5,150 for investigations of the quality of waters, including both surface and underground supplies. Most of the work was done in Connecticut, Georgia, Florida, Mississippi, Arkansas, Texas, Montana, Oregon, Utah, Nevada, California, New Mexico, and Arizona. In addition to the work in these States, the parts pertaining to water supply in a number of geologic folios and other reports prepared by the geologic branch on areas in various States were reviewed and in part written by Messrs. Dole and Meinzer, and progress was made in the preparation of a comprehensive report on the quality of the surface waters of the United States by Mr. Dole, assisted during parts of the year by G. S. Morgan and E. C. Bain.

##### WORK BY LOCALITIES.

*Coastal Plain.*—An investigation of the geology and underground waters of the Atlantic and Gulf Coastal Plain has for the last few years been conducted under the supervision of T. W. Vaughan, of the geologic branch. To this investigation \$1,400 of the funds of the water-resources branch was allotted during the fiscal year 1912–13, and the phases of the investigation relating to the quality of the water were placed in charge of Mr. Dole, of this branch. A general description of the Coastal Plain investigation is given on pages 35–36. The work by Mr. Dole was done chiefly on areas in Georgia, Florida, Arkansas, and Texas.

During the year a report on the water resources of the Coastal Plain province of Virginia, prepared in cooperation with the Virginia Geological Survey by Samuel Sanford, was issued as Bulletin 5 of the State survey, and a similar cooperative report on the water

resources of the Coastal Plain region of North Carolina, by L. W. Stephenson, B. L. Johnson, and H. N. Parker, was issued as Part II of volume 3 of the North Carolina Geological and Economic Survey.

*Connecticut.*—An intensive study of the underground water resources of the State of Connecticut, which was begun in the previous fiscal year, was continued in cooperation with the State Geological and Natural History Survey. This investigation, which is to be extended over a period of years, is being conducted by A. J. Ellis, under the supervision of H. E. Gregory. At the close of the fiscal year the report on the areas thus far covered was nearly completed.

*Iowa.*—A comprehensive report on the underground water resources of the State of Iowa, prepared in cooperation with the State Geological Survey of Iowa by W. H. Norton, W. S. Hendrixson, H. E. Simpson, O. E. Meinzer, and others, was published during the year as Water-Supply Paper 293.

*Texas.*—During the year a report by C. H. Gordon on the geology and underground waters of the Wichita region of north-central Texas was issued as Water-Supply Paper 317, and considerable work was done on the Coastal Plain of this State (pp. 66, 67).

*Montana.*—In response to urgent requests two special investigations were made in Montana; one in the vicinity of Butte, where underground water is in demand for milling operations and for irrigation of truck farms; the other on the Flathead reclamation project, where the settlers are having difficulty in obtaining domestic water supplies. Both areas were examined by Mr. Meinzer in October, 1912, and brief reports were made to the citizens of Butte and, through the United States Reclamation Service, to the settlers on the Flathead project. A water-supply paper on these two areas is in preparation.

*Washington and Oregon.*—During the last three years investigations have been made by Walton Van Winkle of the quality of the waters in Washington and Oregon to determine the availability of these waters for domestic, agricultural, and industrial purposes. The Washington report, based on work done in 1910–11 at the University of Washington in cooperation with the State Board of Health, has been submitted for publication. The Oregon investigation was begun in 1911–12 and was maintained in cooperation with the State of Oregon through the office of John H. Lewis, State engineer. It included the analyses of nearly 1,000 samples of water in a laboratory gratuitously furnished by the Willamette University, at Salem, Oreg. The laboratory work was finished in October, 1912, and on February 28, 1913, Mr. Van Winkle, after completing his report thereon, resigned from the Survey to continue his studies of the water resources of Oregon with the State engineer.

The report by G. A. Waring on the water resources of a part of south-central Washington was published during the year as Water-Supply Paper 316.

*Utah and Nevada.*—A report on the underground water resources and irrigation possibilities of a part of northwestern Utah (Water-Supply Paper 333) was completed by Everett Carpenter in August, 1912, and an investigation of the water resources of southeastern Nevada was begun by Mr. Carpenter in September. At the close of the fiscal year the report on the Nevada area is well advanced. The water analyses for this investigation were made by S. C. Dinsmore, of the experiment station and food and drug commission of Nevada.

At the beginning of the fiscal year Mr. Dole prepared for the geologic branch a report entitled "Exploration of salines in Silver Peak Marsh, Nevada." This report was based on field work done by him in the spring of 1912 and was published as Bulletin 530-R.

*California.*—A report by C. H. Lee on the results of an intensive study of the water resources of a part of Owens Valley, Cal., was published during the year as Water-Supply Paper 294, and an investigation of the amount of percolation of flood waters to the underground reservoir in certain tracts in southern California was continued by Mr. Lee, through cooperation with the California State conservation commission. The report by G. A. Waring on California springs is practically completed, and some progress has been made during the year in the preparation of reports on the underground waters of the San Joaquin Valley, by W. C. Mendenhall, R. B. Dole, and Herman Stabler, and the underground waters of San Jacinto Valley, Cal., by W. C. Mendenhall, the field work in both valleys having been done in previous years.

Two underground water investigations were begun in California in September, 1912—one in the Sacramento Valley by Kirk Bryan, the other in the Santa Clara Valley, south of San Francisco, by W. O. Clark, under the direction of Dr. J. C. Branner. Mr. Meinzer also devoted the month of September, 1912, to these two fields. At the close of the fiscal year field work is progressing in both areas.

*New Mexico.*—An investigation of the underground waters in Luna County, N. Mex., which includes most of the Mimbres Valley, has for the last few years been carried on by N. H. Darton and is now well advanced.

An investigation of the Tularosa Basin and adjacent areas, covering over 6,000 square miles in south-central New Mexico, has been made in cooperation with the New Mexico agricultural experiment station, Mr. Meinzer being in charge of the work done by the Federal Survey and Dr. R. F. Hare, chief chemist of the experiment station, being in charge of the analytical work done by the State. Mr.



Meinzer, after spending about two weeks in November, 1912, in southeastern Nevada, returned to the Tularosa Basin and devoted several weeks to an examination of the region between the Jarilla Mountains and the Rio Grande. The report on the Tularosa area was completed and transmitted for publication before the close of the fiscal year.

*Arizona.*—The report on the geology and water resources of Sulphur Spring Valley, Ariz. (Water-Supply Paper 320), prepared by Mr. Meinzer, of the Federal Survey, in cooperation with R. H. Forbes and F. C. Kelton, of the State experiment station, was sent to the Public Printer during the fiscal year.

The special investigations which for several years have been conducted for the Office of Indian Affairs in the Moki and Navajo reservations, in Arizona, and adjacent parts of New Mexico and Utah, were resumed in May, 1913, by H. E. Gregory, who has from the beginning been in charge of the work. The results of these investigations are reported to the Commissioner of Indian Affairs, to assist the engineers of the Indian Office in developing water supplies. Prof. Gregory is also preparing for publication a water-supply paper on the region.

#### DIVISION OF WATER UTILIZATION.

The work of the division of water utilization has been continued during the year under the organization described in previous annual reports. E. C. La Rue and E. C. Murphy, hydraulic engineers, have performed the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. The work of examining land for designation under the enlarged-homestead act has been performed in part by Mr. La Rue and Mr. Murphy, and in part by W. B. Heroy and W. N. White, geologist and assistant classifier, respectively, in the land-classification board, who were detailed to this work during a portion of the field season.

The personnel of this division and the allotment of funds therefor are insufficient to meet the demands made upon them. Many of the power-site withdrawals still remain unexamined; many applications for rights of way, some of which have been pending in the Survey for more than two years, have not yet been reached; applications for power permits and for segregations of land under the Carey Act, which are now generally acted on by the Survey without field examination, although such examination is often highly desirable, will doubtless in many future cases be referred to the field for report; and applications for designation under the enlarged-homestead act, which require field examination, are constantly accumulating. In addition, the examination and classification of the lands valuable for *power sites and reservoirs* in New Mexico and Arizona, made neces-

sary by the acts of Congress admitting these States (36 Stat., 564 and 575), has not yet been made. These acts provide that—

There is hereby reserved to the United States and exempted from the operation of any and all grants made or confirmed by this act to said proposed State all land actually or prospectively valuable for the development of water powers or power for hydroelectric use or transmission and which shall be ascertained and designated by the Secretary of the Interior within five years after the proclamation of the President declaring the admission of the State.

The proclamation admitting New Mexico was dated January 6, 1912, and that admitting Arizona was dated February 14, 1912. The field examination necessary for the classification of the lands of these two States which are valuable for power is understood to be required of this branch.

#### LAND-CLASSIFICATION BOARD.

##### ORGANIZATION AND PERSONNEL.

The organization of the land-classification board received its present form by Survey Order No. 10, issued May 1, 1912. The organization and personnel for the fiscal year 1912-13 have therefore remained practically as they were during the previous year and as outlined in the thirty-third annual report. The most important changes are those due to the appointment of G. H. Ashley as administrative geologist early in the fiscal year and of N. C. Grover as chief hydraulic engineer in charge of the water-resources branch near the close of the year. Mr. Ashley continues to act as chairman of the coal board, but C. E. Leshner has been named as vice chairman in order to relieve Mr. Ashley of a great part of the detailed work of the section. Herman Stabler has been assigned to the duties heretofore devolving upon Mr. Grover.

On July 1, 1912, the entire personnel of the board numbered 35, of whom 11 were geologists and engineers, 4 draftsmen or other technical workers, and 19 (including 5 temporary employees) of clerical or subclerical grades. This number remained fairly constant throughout the year, there being 34 members on the board's staff at its close—10 geologists and engineers, 4 technical employees, and 20 (including 3 on the temporary rolls) clerical or subclerical. At the end of the year the branch was organized as follows:

W. C. Mendenhall, chief of branch.

Elsie Patterson, secretary.

Division of mineral classification:

Coal section: G. H. Ashley, chairman; C. E. Leshner, vice chairman.

Oil section: M. W. Ball, chairman.

Phosphate section: A. R. Schultz, chairman.

Metalliferous section: A. R. Schultz, chairman.

Division of hydrographic classification:

Water-power section: Herman Stabler, chairman.

Irrigation section: W. B. Heroy, chairman.

## SPECIAL FEATURES.

A feature of the year's work that is worthy of special mention is the revision of the regulations for the classification and valuation of public coal lands. The revised regulations were approved by Secretary Fisher on February 20, 1913. The reasons which led to this revision are set forth in some detail on pages 144-146, and the regulations and the principles which underlie them are given in Bulletin 537, "The classification of the public lands," this bulletin itself representing an important part of the work of the land-classification board.

Other administrative advances to which the land-classification board has contributed are represented by the regulations governing the issue of right-of-way permits for power purposes under the act of February 15, 1901 (31 Stat., 790). The first draft of these regulations was approved by Secretary Fisher on August 24, 1912. They were later modified in minor particulars and were approved in their present form on March 1, 1913.

Similarly, regulations were devised governing procedure under the act of March 3, 1911 (36 Stat., 1253-1254), providing for rights of way for transmission lines. These regulations were finally adopted and approved by Secretary Fisher on January 6, 1913.

While these various special tasks have been accomplished from time to time, the regular work for which the board is organized, namely, classifications of the public lands on the basis of results secured by the field branches and the promulgation of these classifications, has gone steadily forward. These classifications are summarized in the chapter on each resource, but a graphic idea of the work and of the increased efficiency exhibited in its accomplishment may be presented by a summary of the letters and reports written during this year and a comparison with previous years.

Between July 1, 1912, and June 30, 1913, 16,954 letters were referred to the board for reply, an increase of 32 per cent over the previous year, and 19,399 letters and reports were written in the board, an increase of 70 per cent over the production of the previous year. For the working days of the year this was a daily average of 55 incoming and 63 outgoing letters. The greater part of these letters are technical reports upon the mineral or power value of individual tracts of public land. Most of them, of course, are brief letters, but each represents research and makes available a modicum of the Survey's accumulated information. From reports of this simple type those issued by the board vary to full discussions of complex problems 50 pages or more in length. As some of the letters received cover many cases and require a large number of replies, there has been through the year a steady accumulation of unsettled cases, amounting at its end to about

5,600, and this despite the fact that there was a large excess of outgoing reports over incoming inquiries during the year.

That the board has been able to accomplish this great gain in output without increase of force, while at the same time improving its system and rendering its handling of cases more prompt and sure, is due to the standardization of procedure, to the increasing efficiency of the personnel, and to the adoption of time-saving devices, such as multigraphed forms and safety maps.

#### COOPERATIVE CORRESPONDENCE.

The primary purpose for which the land-classification board was created is to assist in the administration and utilization of the public domain. This it does by making available to the department in the solution of public-land problems the experience and judgment of the technical and scientific men on the Survey's staff and the data regarding the character of the public lands contained in the Survey's records. This assistance is rendered, first, by the classification of public lands into types recognized by the statutes; second, by the promulgation of classifications in the form of recommendations for withdrawals or restorations where appropriate; and, third, by cooperative correspondence with other Government offices by which classifications of individual tracts are reported. The classifications themselves are the foundation of the work, but the cooperative correspondence by which these classifications are rendered directly available to the department and to other bureaus absorbs a large part of the energies of the board. By means of this correspondence the Secretary's office, the Indian Office, and the Land Office are supplied with information as to the mineral character of lands or their value for power sites or reservoirs. In the majority of cases the question is whether or not certain lands sought to be acquired from the Government are of the character contemplated by the statute under which their acquisition is attempted.

Thus under the agreement of March 5, 1912, between the Land Office and the Survey all entries and selections except homestead and desert-land entries, valid settlement claims, and metalliferous-mining claims are referred to the Survey for report as to whether or not the lands entered or selected are mineral in character or have power or reservoir possibilities. If the Survey reports the land in a given case to be without value for mineral, power, or reservoir resources, the case is clear-listed by the Land Office, unless other factors prevent, and proceeds to patent. If, on the other hand, the Survey reports the land to be mineral or to have power or reservoir value, the Land Office gives the applicant opportunity to disprove the classification, and in the event that he is unable to do so acts in accordance

with the Survey's report. In cases where the Survey's information is too meager to warrant a definite report, the information available in the Survey's records is furnished to the Land Office for use in an examination by the field service of that bureau. The board received during the year 12,852 requests of this general type and took action upon 9,503.

The benefits of this agreement are threefold. In the first place the public's interest in the appropriate disposition of the public lands is protected, and inappropriate disposition is guarded against so far as can be insured by the fullest use of the data which the Survey has accumulated in the last 30 years. In the second place, the Government is saved the expense of a large number of field examinations. The extent of this saving is shown by the fact that of 9,503 cases handled by the Survey during the fiscal year, field examination was recommended in only 2,815 cases—less than 30 per cent. The saving of time and money to the Land Office field service, which is seriously overburdened at best, is of great importance, enabling that service to devote a greater part of its energies to the many other types of cases of equal urgency which it must investigate. In the third place, inasmuch as the majority of the tracts considered are, as indicated in the table below, reported to be without mineral, power, or reservoir value, the claimant receives his patent in a shorter space of time than if his case must go to the field for examination. Even the applicant whose case requires field examination should receive final action earlier than if all these cases were assigned to the field, because the large number of cases in which field examination is obviated enables the Land Office field service to take up the remaining cases more promptly.

*Action on Land Office requests for information under cooperative agreement of March 5, 1912, during fiscal year 1912-13.*

LAND-CLASSIFICATION BOARD.

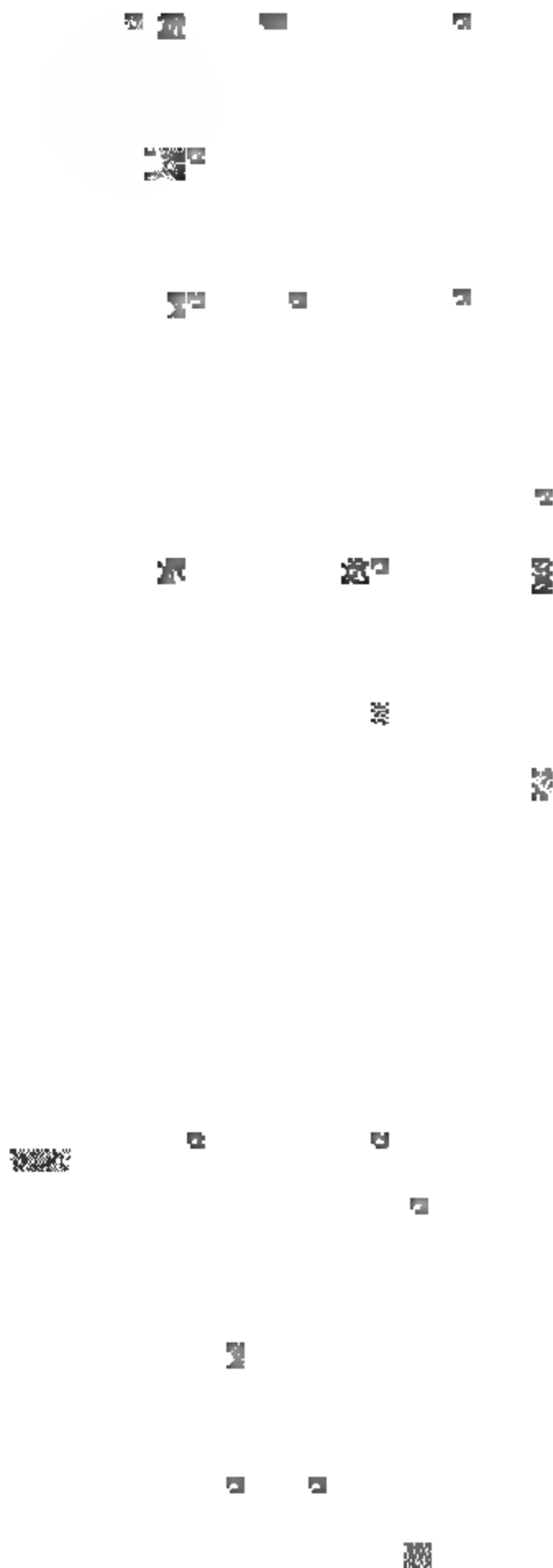
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<sup>a</sup> Certain of these requests are accompanied by field service reports as to mineral character and have been included in the following table, headed "Action on Land Office field-service reports," etc. (p. 141), as follows: Pending July 1, 1912, 504; received, 1,516; acted upon, 1,516; pending June 30, 1913, 636.



Cooperation between the Land Office and the Survey under the agreement of March 5, 1912, does not cease with the furnishing of the information noted above. In cases where the Survey makes a definite report as to the character of the land, it can in general be of no further assistance, but the cases where field examination is recommended are returned to the Survey for review after field examination is made. All field-service reports regarding homestead and desert entries on withdrawn or classified lands that state that the lands are not valuable for the purpose for which they are withdrawn or classified are also forwarded to the Survey for review. By this procedure a great amount of valuable data gathered by the Land Office field service is made available for incorporation into the Survey records, and at the same time the Land Office receives the benefit of the information already on file in the Survey. This information is of especial value because from the very nature of the agreement these reports relate to areas where the Survey's records are incomplete. The character of work done by the Land Office field service is indicated by the fact that of 3,812 reports reviewed by the Survey during the fiscal year only 201 have been disapproved in whole or in part.

*Action on Land Office field-service reports under cooperative agreement of March 5, 1912.*



In addition to the cases which fall within the agreement of March 5, 1912, there are several other types of cooperation with the Land Office by which the Survey's data and the judgment of its technical force are made useful.

Under departmental order of April 27, 1911, all proposed eliminations from national forests are referred to the Survey for report as to whether or not the lands are valuable for coal or have power possibilities. Inasmuch as withdrawals and classifications of lands containing coal are made without regard to national-forest boundaries, no report as to this mineral is necessary, and the Survey reports only as to power-site and reservoir possibilities. The number of these cases is not large, but the area covered is greater than the number of cases would indicate.

Certain other types of cooperation with the General Land Office have already been discussed. Of these, applications for the classification of land included in power-site reserves, desert-land proofs under irrigation projects, applications for rights of way, water-power permits, and Carey Act lists fall within the scope of the division of hydrographic classification, while applications for classification and for reclassification of coal lands are handled by the division of mineral classification. In a majority of these cases a report is furnished to the Land Office for the guidance of that office and of the Secretary.

The cooperative correspondence of the land-classification board is not confined to the Land Office or to the Secretary's office. On March 27, 1911, Secretary Fisher directed that a report as to mineral character and power-site or reservoir possibilities should be obtained before the issuance of patent to Indians under tribal allotments. A renewal of this order on August 23, of that year, directed that to these cases should be given precedence over other work in the Survey. As a result of these orders the Survey receives from the Office of Indian Affairs several thousand requests for information each year, in response to which the Survey either reports the lands as without mineral, power, or reservoir value, or as of value for one or more of these resources, or reports that sufficient information is not available to warrant a definite conclusion. If the Survey's report is definite it is used by the Indian Office as a guide in determining whether or not patent to the lands involved shall issue. The Indian Office has no field service such as that maintained by the Land Office, and the result is that in many cases in which the Survey reports insufficient data for classification the Indian Office requests it to make the necessary investigation to determine water-power or mineral value, that office furnishing the funds. Several of these examinations were made during this year, as noted elsewhere in this report. The number of

- Indian Office cases received and acted upon during the last two years is shown in the following table:

*Action on Indian Office requests for information under departmental orders of March 27 and August 23, 1911.*

Year.	Received.	Acted upon.	Pending.
1911-12.....	4,879	3,385	1,494
1912-13.....	2,917	4,092	319
	7,796	7,477	319

Action on enlarged-homestead petitions is not, strictly speaking, cooperative correspondence, as many of these petitions are received in the Survey directly from the applicants. However, the petitions are in the nature of requests for classification, and the correspondence is similar in its nature to that carried on under cooperative orders. This correspondence is therefore included in the summary table below, which shows the number of cases of each class received during the year, the gain or loss, and the amount of work outstanding at the close of the fiscal year.

*Balance sheet of cooperative cases for year ended June 30, 1913.*

Class of cases.	Pending July 1, 1912.	Received.	Disposed of.	Pending June 30, 1913.	Gain (+) or loss (-).
<b>Mineral only:</b>					
General Land Office requests for information . . .	12	241	193	60	- 48
General Land Office, special agent.....	128	2,165	2,016	275	- 149
Applications for reclassification.....	4	33	22	15	- 11
Applications for classification.....	1	10	11	0	+ 1
	143	2,449	2,242	350	- 207
<b>Water only:</b>					
General Land Office requests for information.....	23	196	175	43	- 20
General Land Office, special agent.....	20	50	54	16	+ 4
Forest Reserve cases.....	16	102	90	28	- 12
Application for reclassification.....	16	25	22	19	- 3
Carey Act lists.....	1	18	19	0	+ 1
Right-of-way applications.....	128	546	637	37	+ 91
Enlarged-homestead petitions.....	349	1,944	946	1,347	- 998
Water-power permits.....	0	37	19	18	- 18
Desert proofs, irrigation projects.....		117	102	15	- 15
	553	3,034	2,064	1,523	- 270
<b>Both:</b>					
General Land Office requests for information.....	1,392	8,838	7,619	2,611	-1,219
General Land Office, special agent.....	79	327	226	180	- 101
Special Agent mineral, requests for information, power.....	564	1,587	1,516	635	- 71
Indian Office cases.....	1,494	2,917	4,092	319	+1,175
	3,529	13,669	13,453	3,745	- 216
<b>Grand total.....</b>	<b>4,225</b>	<b>19,152</b>	<b>17,759</b>	<b>5,618</b>	<b>-1,393</b>

## DIVISION OF MINERAL CLASSIFICATION.

## GENERAL FEATURES.

The division of mineral classification in the land-classification board corresponds to the geologic branch in the Survey. It receives from this field branch the results of the field operations of its staff and prepares from these results the official classifications of mineral lands. As heretofore, the largest item in the work of the division is that of coal-land classification. During the year 9,959,880 acres of lands were classified as to their coal content, mainly on the basis of field reports rendered by the geologic branch. Classifications of lands valuable for other minerals have likewise continued as heretofore, and in general restorations have exceeded withdrawals. As the outstanding withdrawals at the beginning of the fiscal year included most of the lands believed to be valuable for the minerals for which they were withdrawn, the examinations made during the year permitted restoration of a portion of these lands which proved not to contain the minerals in question. In coal lands, for example, the total area of new withdrawals recommended during the year was 145,764 acres, while the area of restorations effected was 9,497,468 acres. These restorations, however, do not mean that the lands do not contain coal. Coal lands as well as noncoal lands are restored to entry as soon as prices based on their coal content have been placed on them.

The withdrawals of oil lands during the year amounted to 124,736 acres, and the restorations of lands previously withdrawn amounted to 302,780 acres. The phosphate withdrawals during the same period included 95,200 acres and the restorations 513,205 acres, the result being a reduction of the area included in phosphate withdrawals at the end of the fiscal year to less than 3,000,000 acres. Minor acreages of potash lands were withdrawn, special naval petroleum reserves were created, and the classifications of metalliferous mineral lands within the Indian reservations and within the limits of the Northern Pacific Railroad grants in Idaho and Montana were continued. Details of this action are reported on pages 147-156.

## COAL.

## NEW REGULATIONS GOVERNING THE CLASSIFICATION AND VALUATION OF COAL LANDS.

The coal-land regulations in operation at the beginning of the fiscal year were those approved by Secretary Ballinger April 10, 1909, as amended June 6, 1910. It had long been evident that certain changes in those regulations were desirable, chiefly because the groups into which they divided coals for the purpose of classification and valuation proved to be not adapted to this purpose and because they did not take cognizance of certain factors that have been found to *have an important bearing* on coal classification. For example, the

regulations of April 10, 1909, divided coal into four distinct classes, whereas as a matter of fact no such distinct classes exist in nature. On the basis of this fourfold classification different depth limits and prices were fixed. It sometimes happened that for a coal on the border line between two of these classes the decision had to be made whether the depth limit should be 500 feet or 2,000 feet, while it should be, as a more natural classification would permit, say, 1,200 feet. The depth limits of two coals which may differ but slightly must needs under that scheme be fixed in the one case at 500 and in the other at 2,000 feet. There was no provision for graduation between those points or between 2,000 and 3,000 feet. One effect of this provision was that when a coal bed that changes slightly in character is traced along the outcrop the point may be reached where it passes from one class to another and the depth limit there suddenly changes. At this point the classification of the overlying surface as coal land would at once shift 1 mile or even 2 miles without any obvious or, indeed, any logical reason. Again, under those regulations all coals of one class were given the same depth limit, regardless of differences of quality within that class or of differences in thickness.

Studies carried on for over a year by the coal-land-classification board, assisted by other coal experts, resulted in the drafting of a new set of regulations governing the classification and valuation of coal land, and these regulations were on February 20, 1913, approved by Secretary of the Interior Fisher. The changes made were intended primarily to meet the difficulties just set forth by providing for graduated changes in depth limit, in minimum thickness, in prices, and in other like features. To do this the new regulations adopt a uniform gradient of prices in accordance with the heat value of the coal as expressed in British thermal units but allow a margin of elasticity for special qualities that enhance that value or detract from it. The superseded regulations provided a minimum thickness of 14 inches for all coals from 15,000 British thermal units or more down to 10,500 British thermal units, then increased the thickness at the rapid rate of 1 inch for each decrease of 100 British thermal units. The new regulations use the same thickness for the coals above 12,000 British thermal units, then increase that thickness at a varying rate down to 8,000 British thermal units, the final result being to maintain the same minimum thickness as before for the high-grade and low-grade coals but to increase the minimum slightly on intermediate coals, so as to eliminate the abrupt change that previously existed. Furthermore, in the new regulations the depth limit is determined in accordance with the quality and thickness of the coal, on the basis that the depth at which any coal can be commercially mined is dependent on the profit that may be derived



from its extraction. A factor not taken into account by the old regulations is the rapid increase in the cost of mining thin beds with decrease in thickness. It was found by careful study of mining experience that this increase is not directly proportional to the thickness of the bed, but increases at a greatly accelerated rate as the thickness decreases below 6 feet. It is also recognized that the percentage recovery of coal is greater for thin beds than for thick beds, a fact which tends to offset the increased cost of mining thin beds. These various factors were considered in framing the provisions of the new regulations. Another change which, it is believed, will eventually work to the benefit of the buyer of coal land, particularly the man of small means, is a provision in the regulations made effective November 15, 1912, by Secretary Fisher and included in the new regulations of February 20, 1913, that, where for good reasons it is advisable, classification of coal land may be made by  $2\frac{1}{2}$ -acre or 10-acre tracts or multiples thereof, described as minor subdivisions of quarter-quarter sections or rectangular lotted tracts. The reason for this provision is apparent when it is realized that the classification as coal land of a tract only partly underlain by coal often results in valuing at the minimum of \$10 or \$20 an acre lands whose price obtained by dividing the total estimated coal value by the number of acres in the subdivision is only a few dollars an acre, but for which, under the law, the minimum price of \$10 or \$20 an acre must be charged. A second advantage to the purchaser of small means is obtained in offering for sale small tracts along the outcrop of certain coal beds, in that this procedure will permit the purchase of a sufficient area to warrant the opening of a small country bank for meeting local demands under conditions which will not warrant the investment of the amount of capital necessary to purchase the entire 40-acre tract.

The general effect of the regulations of February 20, 1913, is to increase the area classified as coal land underlain by beds of the best quality and of thicknesses over 6 feet and to decrease the area classified as coal land but underlain by the poorer coals or by beds less than 6 feet in thickness. These changes are due to modifications of the depth limit for coals of the various grades and thicknesses. Values per acre are increased slightly for land in which the coal exceeds 15 feet in thickness and are decreased materially for land containing beds from 2 to 5 feet in thickness. The latter effect in turn results in a greater acreage valued at the minimum price.

#### CLASSIFICATIONS.

The fiscal year 1912-13 has shown a notable decrease in the area of land included in outstanding withdrawals, the reduction being due to the fact that the lands examined, classified, and restored have greatly exceeded the area withdrawn during the year.

During the fiscal year 2,064,014 acres were classified as coal land and valued at \$33,477,908, and 7,895,866 acres were classified as noncoal land. A large part of the area classified as coal land was in the region of low-grade coals of North Dakota, South Dakota, and eastern Montana, although several small fields of higher grade coal in north-central Montana, Idaho, Utah, Wyoming, and New Mexico have been examined and classified. Every effort was made during the year to obtain information regarding withdrawn areas which were believed to be largely noncoal lands in order that such areas might be eliminated from the withdrawal. Field work in areas containing thick and high-grade coals has been done with greater detail than before and consequently covers smaller areas than in previous years. These examinations during the last year were made for the most part in areas previously classified as coal land on preliminary examinations made several years ago. The total area and value of coal land classified as the result of the later work, though varying somewhat from those fixed by the previous classification of the same land, does not materially increase the total area classified as coal land or the total value. No small part of the work has been the classification of lands in Indian reservations that were thrown open to settlement. The following table shows the progress of coal-land classification by States:

*Summary of coal-land classifications and valuations June 30, 1912 and 1913.*

## SALES OF COAL LAND.

The sale of coal land at the new figures has continued at a moderate rate during the last year, as during the years immediately preceding. In all 10,338.70 acres were sold for \$270,396.90, an average price of \$26.15 an acre. These sales indicate that the suggestion once made that coal lands would not sell at the new figures was not well founded. Indeed, owing to the increased detail with which the work in the field is being done, there is a growing tendency to accept the Survey's appraisal as a fair indication of the value of the lands classified by it. Increase in the coal production of the Rocky Mountain States during the last few years indicates that the coal industry of that region has not been injured by the Survey's work, as some feared it might be. Under the regulations now in force a large part of the public coal land will continue to be classified at the minimum price. All the land in the Dakotas is being so priced, and much of that in Montana, besides a considerable percentage of land classified in other States, and purchases will continue to be made at the minimum price.

The following table shows the prices at which coal lands have been sold, the number of entries at the different prices, the number of acres sold at these prices, and the receipts since July 1, 1907:

*Sales of coal lands at various rates since July 1, 1907.*

Price per acre.	Entries to date.	Acres.	Receipts.	Price per acre.	Entries to date.	Acres.	Receipts.
\$10.00	395	55,891.05	\$559,834.63	\$100.00	2	233.29	\$23,329.00
12.50	1	56.03	700.38	110.00	.....	198.73	21,800.60
14.50	1	40.00	580.00	115.00	.....	63.19	7,266.62
15.00	16	2,470.55	37,058.25	120.00	2	121.68	
17.50	1	40.00	700.00	130.00	2	201.73	
19.00	1	22.80	433.20	135.00	2	136.96	
20.00	208	57,553.51	967,438.40	140.00	1	120.00	
25.00	42	11,811.68	147,671.00	145.00	1	40.00	
30.00	26	3,279.81	98,394.30	150.00	.....	22.33	
33.00	1	40.00	1,320.00	155.00	2	120.08	
35.00	3	279.78	9,792.30	170.00	1	39.89	
36.00	1	40.00	1,440.00	175.00	.....	16.21	
40.00	0	880.72	35,228.80	180.00	1	40.00	
45.00	2	360.00	16,200.00	200.00	.....	77.06	
49.00	1	40.00	1,960.00	270.00	1	39.79	
50.00	70	8,338.63	415,023.00	370.00	1	41.40	
60.00	1	160.00	9,600.00	375.00	1	41.73	
65.00	.....	240.00	15,600.00	385.00	2	83.14	
70.00	1	80.79	5,655.30	390.00	1	41.64	
75.00	2	161.23	12,092.25	395.00	2	124.63	
80.00	.....	40.00	3,200.00	400.00	2	83.15	
85.00	1	40.00	3,400.00	405.00	3	166.51	
90.00	2	204.96	18,446.40	410.00	2	83.39	
92.00	1	40.00	3,680.00				
95.00	1	38.51	3,658.45				
					905	144,286.58	2,731,745.71

## WITHDRAWALS AND RESTORATIONS.

The area of lands withdrawn during the fiscal year 1912-13 has been small compared with that withdrawn during preceding years and is considerably less than the area classified and restored, so that at the end of the year there is a considerable net decrease in the area withdrawn over that withdrawn on June 30, 1912. The following

table shows by States the coal lands withdrawn and restored during the fiscal year 1912-13:

*Coal lands withdrawn and restored during fiscal year 1912-13.*

[In acres.]

State.	Outstand- ing July 1, 1912.	New with- drawals during fis- cal year.	Restora- tions dur- ing fiscal year.	Outstand- ing June 30, 1913.
Arizona.....	118,718	.....	.....	118,718
California.....	239,903	.....	.....	239,903
Colorado.....	8,245,063	8,826	3,216,168	5,037,721
Idaho.....	1,566,918	.....	1,175,132	391,786
Montana.....	17,642,291	44,077	1,634,453	16,051,915
Nevada.....	92,141	.....	8,308	83,833
New Mexico.....	5,750,440	.....	11,593	5,738,847
North Dakota.....	18,454,410	.....	2,533,123	15,921,287
Oregon.....	3,521	23,040	.....	26,561
South Dakota.....	866,809	.....	866,809	.....
Utah.....	6,364,783	67,340	160	6,431,963
Washington.....	2,206,190	.....	160	2,206,030
Wyoming.....	6,664,302	2,481	51,562	6,615,221
	68,215,489	145,764	9,497,468	58,863,785

APPLICATIONS FOR CLASSIFICATION.

The number of applications for classification is decreasing from year to year, having fallen from 46 in 1910-11 to 10 during the last fiscal year. This decrease is doubtless due in part to the classification and restoration of large areas of noncoal land previously withdrawn, but probably to a greater extent it is due to a better understanding of the operation and effect of the act of June 22, 1910, providing for agricultural entries on lands withdrawn or classified as coal land, and to the act of April 30, 1912, extending the act of June 22, 1910, to State selections and isolated tract sales. There still remain, however, a few entrymen who object to patents reserving coal to the Government and who file applications to have lands classified as noncoal land. Most of the affidavits by which such applications are supported are valueless, and therefore few such requests can be granted, as the withdrawals are made for the purpose of retaining title to the coal in the Government until information adequate for classification is obtained. There have also been received a few applications for the classification and valuation of lands which it is desired to purchase as coal land. The following table shows the action taken upon applications for classification received through the Land Office or the department:

*Applications for classification of withdrawn coal lands.*

	Re- ceived.	Ap- proved.	Denied.	Pending.
1910-11.....	46	4	36	6
1911-12.....	18	1	22	1
1912-13.....	10	4	7	0
	74	9	65	0

APPLICATIONS FOR RECLASSIFICATION.

In order to guard against possible errors in classification, whereby injustice might be done, provision is made for applications for reclassification. Any person desiring to enter or select, under the agricultural laws, lands classified as coal lands may submit an application for reclassification, supporting it by affidavits setting forth the evidence which seems to him to show that the existing classification is erroneous. As a rule, the affidavits thus submitted are of the most perfunctory sort and are barren of facts affecting the classification. Now and then, however, an application is accompanied by valuable information, to which most careful consideration is given, and when this information shows the previous classification to be in error a reclassification is made.

In addition to the applications filed by entrymen requesting that lands classified previously as coal land be reclassified as noncoal land, the Survey received during the year a small number of applications for the reclassification of lands previously classified as noncoal land, the entryman desiring to purchase as coal land. Some of these applications have resulted in new field examinations by the Survey and, on the basis of the data gathered, a reclassification as requested.

There were also received late in the fiscal year several applications for reclassification, alleging the values fixed by the Survey to be too high and praying that lower appraisal be made. These applications were filed as the result of departmental decisions especially authorizing their submission. The information submitted with most of the applications was not of a character to be of assistance in arriving at correct valuations, and a careful review of all the data available led to the conclusion that the values already fixed were reasonable and in accordance with departmental regulations and to a denial of the applications. The following table shows the action on applications for reclassification submitted through the Land Office or the department since they first began to be received:

*Applications for reclassification of coal lands.*

	Received.	Ap- proved.	Part ap- proved.	Denied.	Pending.
1909-10.....	126	3	3	116	4
1910-11.....	48	.....	.....	21	<sup>a</sup> 29
1911-12.....	29	.....	.....	53	<sup>b</sup> 4
1912-13.....	33	4	.....	18	15
	236	7	3	208	15

<sup>a</sup> One case canceled by relinquishment and one returned to entryman.  
<sup>b</sup> One case recalled by General Land Office.

## OIL.

A very important piece of legislation enacted during the year was the act of August 24, 1912, providing for agricultural entries on oil and gas lands in the State of Utah. The bill as originally introduced in Congress applied to all the States of the Union but was changed in committee to apply only to a single State, the committee reporting that the bill was to a certain extent experimental in character and should be extended to other parts of the public domain if found satisfactory. As the table below shows, there are 1,952,326 acres included in oil reserves in Utah, and these lands are now open to homestead entries, desert-land entries, isolated tract sales, State selections, including Carey Act segregations, and Reclamation<sup>300</sup> ice withdrawals, the claimant being entitled, when he has complied with the law, to a patent containing a reservation to the United States of all oil and gas deposits and the right to prospect for, mine, and remove them. In order to guard against disposition under the unsatisfactory placer law of deposits underlying lands so entered or selected, the act provides that "the reserved oil and gas deposits in such lands shall be disposed of only as shall be hereafter expressly directed by law." A second act, that of February 27, 1913, provides for selection by the State of Idaho of lands which have been withdrawn or classified as oil lands or which are valuable for oil. So far as known to the Survey there are in the State of Idaho no deposits of oil or gas of sufficient importance to warrant withdrawal or classification. The act is, however, a step in the desired direction of extending the separation principle to all public-land States.

During the year the area restored to entry has exceeded that withdrawn from entry by 178,044 acres. The two withdrawals made during the year comprise an area in the northern part of the Wind River Basin, Wyo., and an area in the vicinity of Moorcroft, Wyo. Large areas in California which investigations during the fiscal year showed to be unfavorable for oil and gas accumulation were restored.

One of the most important events of the year was the segregation of naval petroleum reserves in California aggregating 68,249 acres and estimated to contain 250,000,000 barrels of oil. As early as February 24, 1909, the attention of Secretary Garfield was called to the superiority of liquid fuel for the Navy and the desirability of retaining a supply thereof in Government ownership. During the last year the Navy Department requested of the Department of the Interior the special segregation of an area estimated to contain a sufficient supply of fuel oil for the Navy's needs for 25 years. Accordingly, two naval petroleum reserves were created—No. 1, including a part of the Elk Hills on the west side of the San Joaquin Valley, on September 2, 1912; and No. 2, comprising a portion of



the Buena Vista Hills, in the same general locality, on December 13, 1912. Both these areas were already included in oil withdrawals, and their inclusion in naval petroleum reserves does not, therefore, add to the total acreage withdrawn. The following table shows the outstanding areas, as well as the action taken during the year by States:

Summary of oil withdrawals, fiscal year 1912-13.  
[In acres.]

State.	Outstand- ing July 1, 1912.	New with- drawals.	Restora- tions.	Outstand- ing June 30, 1913.
and y	230,400			230,400
	1,616,011		227,931	1,388,080
Colorado	87,474			87,474
Louisiana	414,720			414,720
Oregon	74,849		74,849	
Utah	1,952,326			1,952,326
Wyoming	398,402	124,736		523,138
	4,774,182	124,736	302,780	4,596,138

PHOSPHATE.

The examination of phosphate deposits in Idaho, Montana, and Utah was continued during the summer of the present fiscal year along the same lines as in Idaho in 1911-12. Nearly all the phosphate examinations were of a detailed type and were restricted to areas included in outstanding phosphate reserves, and consequently resulted in covering much smaller areas than during the preceding season. The results of the year's activities did not materially extend the knowledge of the distribution of the western phosphate deposits. Reports of the occurrence of phosphate deposits at different stratigraphic horizons and in areas remote from the known phosphate fields were received from various men engaged in geologic examinations in the Rocky Mountain States, but from none of these localities was sufficiently definite evidence submitted to warrant further field examination.

The results of the detailed examinations, as in previous years, have materially modified the outstanding reserves and have added new tracts to the area withdrawn. New information gathered during the year has led to the withdrawal of additional lands not previously known to contain phosphate beds and to the restoration of areas found to contain no valuable phosphate deposits. As predicted in the report on this subject for 1912, the restorations for this fiscal year exceed the withdrawals by more than a quarter of a million acres, with a corresponding reduction in the area of the outstanding reserves. Future field examinations will probably result in further eliminations and perhaps in some additions to outstanding with-

drawals. The results of the phosphate examinations for the fiscal year 1912-13 are set forth in the following summary:

*Withdrawals and restorations of phosphate lands, fiscal year 1912-13.*

[In acres.]

State.	Outstand- ing July 1, 1913.	Withdraw- als during year.	Restora- tions dur- ing year.	Outstand- ing June 30, 1913.
Florida.....	35,640	84,817	.....	120,457
Idaho.....	1,058,056	.....	141,287	916,769
Montana.....	274,861	.....	.....	274,861
Utah.....	107,745	.....	.....	107,745
Wyoming.....	1,864,259	10,383	371,918	1,502,724
	3,340,561	95,200	513,205	2,922,556

No phosphate examinations were made in Florida during the year. There were, however, 84,817 acres of vacant Government land in the phosphate region withdrawn from entry and made a part of the Florida phosphate reserve, pending an examination and classification of the lands or the enactment of legislation providing for the disposition of the phosphate deposits under laws more satisfactory than the present placer-mining law. In order to minimize as far as possible the hardships caused to agricultural interests in Florida, only vacant Government lands in the general phosphate region were included in the phosphate withdrawals.

There has been no change in the procedure as regards classification of phosphate lands during the fiscal year 1912-13. The regulations governing the withdrawal and restoration of phosphate lands have not been modified and are those adopted in 1912. Deposits containing less than 30 per cent of tricalcium phosphate are considered nonmineral lands. Phosphate beds that are 6 feet or more thick and contain 70 per cent or more of tricalcium phosphate are reserved to a depth of 5,000 feet. Thinner and low-grade phosphate beds are held to depths ranging from the maximum of 5,000 feet to a minimum of zero at the surface.

No legislation providing for the disposition of phosphate deposits in the public domain has been enacted during the year, and the mineral must still be acquired, if at all, under the lode or placer law. Legislation was enacted during the year, however, that provides for the State selection of otherwise unreserved public lands of the United States in the State of Idaho which have been withdrawn or classified as phosphate or oil lands, reserving to the United States the right to the phosphate and oil in such lands. It would be advantageous if the separation principle were extended to all forms of homestead entry. Such a law would relieve the agricultural interests in those areas where the withdrawn phosphate lands are valuable for agriculture.

POTASH.

Field work undertaken by the Survey in the search for potash has heretofore been largely of an exploratory character, but during the last year important principles have been established which will be of material assistance in future work. During the year a number of shallow drill holes were sunk in some of the old lake basins in Nevada and California and a careful study was made of some of these lakes. Some of these experiments are yielding significant and perhaps important results. As promising areas that may prove of value as sources of potash are discovered, the public land included in such areas is withdrawn from entry until its value for potash can be demonstrated or disproved. As a result of the Survey's reconnaissance examinations in California and Nevada, 133,829 acres have been included in potash withdrawals.

*Withdrawals of potash lands, fiscal year 1912-13.*

[In acres.]

State.	With- drawals.	Outstand- ing June 30, 1913.
California.....	94,407	94,407
Nevada.....	39,422	39,422
	133,829	133,829

METALLIFEROUS LANDS.

WITHDRAWALS.

During the year a withdrawal of an unusual type, designated mineral-land withdrawal No. 1, Arizona No. 1, was made. The withdrawal covers an area in the Warren mining district (Bisbee, Ariz.), in which investigations by the Survey revealed geologic conditions favorable to the occurrence of deep-seated deposits of copper on which no surface discovery, as required by the lode law, can be made. As a result, discovery and hence valid location will depend on expensive deep drilling or deep shafting and will require time. There was danger that before prospecting of these types could be completed attempts would be made to obtain title to the lands by means of State selections or other nonmineral entries. Accordingly the President directed that an area including approximately 9,787 acres be withdrawn. The lands in the withdrawn area are open to exploration and purchase under the mining laws, so far as they apply to metalliferous minerals, but are not subject to other forms of entry. Later 1,280 acres of this reserve were restored to entry.

## CLASSIFICATION.

Under the act of February 26, 1895 (28 Stat., 683), provision was made for classifying, with regard to their mineral or nonmineral character, the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho, the work to be done by commissioners appointed for the purpose. The classifications made proved unsatisfactory for many areas, and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 703). At the request of the General Land Office, the reclassification was made by the Survey. The field examination of these lands was first undertaken by the Survey during the field season of 1910, when 176,031 acres were classified as mineral and 112,434 acres as non-mineral. The work was continued during the field season of 1911, when 20,270 acres were classified as mineral and 137,036 acres as non-mineral, and during the year 1912, when the work was completed, except as to a few small tracts in Montana.

The results of the Northern Pacific classification work for the three years, 1910, 1911, and 1912, are shown in the following table:

*Lands in Northern Pacific Railroad grant in Montana and Idaho classified by United States Geological Survey.*

[In acres.]

	Classified prior to July 1, 1912.	Classified during fiscal year 1912-13.	Classified June 30, 1912.
Mineral.....	196,309	20,800	217,109
Nonmineral.....	249,550	66,770	316,320
	445,859	87,570	533,429

Lands in the Keams Canyon or White Mesa copper district, in the Navajo Indian Reservation, Ariz., were examined by the Survey at the request of the Secretary of the Interior, and a report regarding the mineral character of these lands was furnished to the Commissioner of Indian Affairs. A report of a similar character was furnished to the Commissioner of the General Land Office regarding the Humboldt group of mining claims in the San Poil mining district, Wash. Reports on the mineral classification of the Deer Horn group of mining claims in the Nespelem Valley, Wash., and on three townships in the Myers Creek mining district, in the north half of the former Colville Indian Reservation, Wash., were sent to the Secretary of the Interior.

Lands within the Colville and Yakima Indian reservations, Wash., and the Blackfeet and Flathead Indian Reservations, Mont., were examined for the Indian Office by the Survey in order to separate the

mineral from the nonmineral lands as a basis for sales and allotments. The work in the Blackfeet and Flathead reservations was undertaken by the Survey during the field season of 1911 and continued during the field season of 1912. The examinations in the Blackfeet and Yakima Reservations were completed, but in the other two reservations the work was only partly completed and will be continued during the season of 1913. The work in these reservations during the two years 1911 and 1912 resulted in classifications as follows, these classifications being made during the fiscal year, 1912-13:

*Lands in present and former Indian reservations in Washington and Montana classified by United States Geological Survey.*

	Acres.
Mineral -----	1, 590
Nonmineral -----	1, 616, 723
	1, 618, 313

#### DIVISION OF HYDROGRAPHIC CLASSIFICATION.

The division of hydrographic classification considers reports of field examination and other data involving water supply and water utilization on the public lands and prepares classifications and correspondence based thereon. The scope and amount of the work of this division are briefly summarized in the following pages.

#### WATER POWER.

##### WITHDRAWALS AND RESTORATIONS.

The classification of the public lands with relation to their value in connection with water power was continued during the year, the withdrawals being made under the authority conferred by the two acts of June 25, 1910 (36 Stat., 847; 36 Stat., 858), and the act of August 24, 1912 (37 Stat., 497). On July 1, 1912, the area included in outstanding withdrawals was 1,813,753 acres. During the year, as a result of additional information procured largely through field investigations by the topographic and water-resources branches, 152,727 acres additional were withdrawn and 68,075 acres previously included in power-site reserves were determined to be without sufficient value to warrant the continuance of the withdrawal and were restored to the public domain. On June 30, 1913, the total area withdrawn in connection with water powers was 1,898,405 acres.

The following table shows the action taken during the last year and the areas outstanding, classified by States:

*Power-site reserves.*

[In acres.]

	Outstand- ing July 1, 1912.	New with- drawals during fiscal year.	Restora- tions dur- ing fiscal year.	Outstand- ing June 30, 1913.
Arkansas.....		17,704		17,704
Arizona.....	192,961		5,730	187,231
California.....	165,008	61,733	4,350	222,391
Colorado.....	244,653	10,007	40	254,620
Idaho.....	295,457	33,563	37,099	291,921
Minnesota.....	11,254		532	10,722
Montana.....	151,106	1,259	2,465	149,900
Nevada.....	15,295	372		15,667
New Mexico.....	14,536		959	13,577
Oregon.....	184,243	15,567	4,145	195,665
Utah.....	375,030	1,485		376,515
Washington.....	103,141	3,826	7,469	99,498
Wyoming.....	61,069	7,211	5,286	62,994
	1,813,753	152,727	68,075	1,898,405

APPLICATIONS FOR RECLASSIFICATION.

Nineteen applications for the reclassification of lands included in power-site reserves have been received during the year from persons desiring to obtain title to the lands withdrawn. On nine applications favorable action has been taken, investigation having disclosed the fact that the lands desired are not primarily valuable for use in connection with water-power development. Eight applications were denied because of the water-power value of the lands. At the close of the year 18 applications were awaiting action.

WATER-POWER PERMITS.

Departmental regulations of August 24, 1912, and March 1, 1913, under the act of Congress approved February 15, 1901 (31 Stat., 790), charge the Survey with important administrative duties in connection with applications for permits to use rights of way over the public lands for purposes relating to the development of water power. Such applications when received in proper form at the General Land Office are now forwarded to the Survey for consideration. The Survey is required to consider such matters as relative priority of applications, incompatibility of works, relative beneficial utilization of resources, as well as the engineering and economic features involved in the applications and permits. If the approval of an application is found to be compatible with the public interest, the Survey prepares a draft of permit setting forth terms on which the use of the desired right of way is to be conditioned and makes report on the circumstances in the case.

The first cases of this nature were several pending applications forwarded from the Secretary's office on August 26, 1912. During the fiscal year 37 applications for permits have been received by the Sur-

vey. Permits have been prepared for 7 of these, with aggregate total capacity of 51,100 horsepower, and for 2 involving only transmission lines. At the close of the fiscal year 18 applications for permits were pending, 10 having been returned to the General Land Office without action or with unfavorable recommendation.

TRANSMISSION-LINE GRANTS.

On January 6, 1913, departmental regulations under the act of March 4, 1911 (36 Stat., 1253-1254), were approved. These regulations require applications under this act to be made and considered in the same manner as applications for permits under the act of February 15, 1901 (31 Stat., 790). Accordingly, duties such as are outlined above with reference to the earlier act now devolve upon the Survey in connection with term grants of easements for transmission lines. During the fiscal year five applications of this type have been received by the Survey. On two of these favorable action was taken; the remaining three were pending on June 30, 1913.

RIGHT OF WAY APPLICATIONS.

In addition to applications for permits for hydroelectric developments a large number of applications for rights of way of various types are referred to the Geological Survey for consideration and report. These embrace applications for rights of way for railroads under the acts of March 3, 1875 (18 Stat., 482), and March 2, 1899 (30 Stat., 990), affecting public lands and Indian reservations, respectively, on which report is made as to whether or not the construction of the railroad will interfere with power or irrigation development on streams in the vicinity of the right of way; applications for rights of way under the act of March 3, 1891 (26 Stat., 1095), for irrigation uses, report being made on interference with power development, the feasibility of the project, and other features of the application; applications for rights of way across national forests for the development of power under the act of February 1, 1905 (33 Stat., 628); and a variety of miscellaneous applications for domestic, municipal, mining, and railroad water supply. The number of each type received and the action taken thereon is indicated in the following table:

*Applications for rights of way.*

	Railroad.	Irriga- tion.	Water power.	Miscella- neous.	Total.
Pending July 1, 1912.....	44	70	7	7	128
Received July 1, 1912, to June 30, 1913.....	114	383	9	23	539
Acted on July 1, 1912, to July 30, 1913.....	139	435	16	40	630
Pending June 30, 1913.....	19	18	.....	.....	37



## IRRIGATION.

## RESERVOIR WITHDRAWALS.

In addition to withdrawals of lands which appear to be primarily valuable in connection with water-power development, a number of reservoir sites, principally valuable for irrigation storage, have been investigated by the Geological Survey and the lands included therein withdrawn from entry under one or the other of the withdrawal acts.

The area included in such withdrawals at the close of this fiscal year is shown in the following table:

*Reservoir-site reserves.*

[ In acres.]

State.	Outstand- ing July 1, 1912.	New with- drawals during fis- cal year.	Restora- tions during fiscal year.	Outstand- ing June 30, 1913.
Arizona.....	23,040	.....	.....	23,040
Montana.....	15,640	.....	.....	15,640
North Dakota.....	1,569	.....	.....	1,569
Oregon.....	16,884	.....	6,265	10,619
South Dakota.....	8,542	.....	.....	8,542
Washington.....	31,553	4,530	.....	36,083
	97,228	4,530	6,265	95,493

## CAREY ACT SEGREGATIONS.

On July 1, 1912, one proposed segregation list under the Carey Act was awaiting report by the Survey as to available water supply, general feasibility of plan of reclamation, and mineral character of the lands. Eighteen lists were received for report during the year, and 14 cases were submitted for reconsideration in connection with additional information. Three of the new lists and nine of those reconsidered received favorable report. The remainder were reported adversely in whole or in part because of insufficient water supply or inadequacy of the plan of reclamation. Suggestions for modification of plans were made in several cases.

## IRRIGATION PROJECTS.

In addition to reporting on rights of way for canals, ditches, and reservoirs for irrigation, the Geological Survey, by the instructions of the Secretary of the Interior dated March 15, 1913, furnishes the Commissioner of the General Land Office with all information at hand relative to the water supply available and the feasibility of irrigation projects, water rights, or shares in which are presented as evidence of compliance with the requirements of the desert-land act. Under these instructions 117 such projects have been considered in the Geological Survey, and all have been reported on except 15, which were pending at the close of the fiscal year.

## ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), and June 13, 1912 (37 Stat., 132), was continued during the year, the acts now being applicable to 12 States. The area designated represents a substantial increase over that classified in the previous fiscal year. The increased acreage is a result in large part of surface and underground water investigations in Idaho, Montana, Utah, and New Mexico, together with the first designations in North Dakota. The following table summarizes the work of the fiscal year:

*Status of enlarged-homestead designations.*

[In acres.]

State.	Outstand- ing July 1, 1912.	Designa- tions during fiscal year.	Cancellations during fiscal year.	Outstand- ing July 1, 1913.
Arizona.....	26,959,779	.....	.....	26,959,779
California.....	.....	1,793	.....	1,793
Colorado.....	20,365,536	17,181	.....	20,382,717
Idaho:				
Secs. 1-5 only.....	5,424,628	139,973	22,363	5,542,238
Sec. 6.....	7,801	7,053	200	14,654
Total.....	5,432,429	147,026	22,563	5,556,892
Montana.....	32,028,776	219,353	646	32,247,493
Nevada.....	49,512,960	.....	9,451	49,503,509
New Mexico.....	16,443,652	1,464,067	.....	17,907,739
North Dakota.....	.....	130,502	.....	130,502
Oregon.....	11,357,888	160,048	.....	11,517,936
Utah:				
Secs. 1-5 only.....	6,943,671	126,870	4,552	7,065,989
Sec. 6.....	1,201,600	17,951	18,865	1,200,686
Total.....	8,145,271	144,821	23,417	8,266,675
Washington.....	3,402,896	6,001	.....	3,406,897
Wyoming.....	17,587,973	32,800	.....	17,620,773
	191,237,160	2,323,612	56,077	193,504,695

The general provisions of the act, which apply in all 12 States, permit the entry by one person of 320 acres of "nonmineral, non-irrigable, unreserved, and unappropriated surveyed public lands which do not contain merchantable timber." As a prerequisite to the allowance of such an entry the land must have been designated by the Secretary of the Interior as not being, in his opinion, susceptible of successful irrigation at a reasonable cost from any known source of water supply. The Geological Survey is primarily engaged in determining the nonirrigable character of the lands in making recommendations of designations, but under the Secretary's instructions, which have been in force during the fiscal year, all lands which are not enterable under the act are eliminated from the lists. The work has thus not only required careful field investigations to determine the physical characteristics of the land, but after report is received

it has been necessary to obtain from the General Land Office the status of the lands which are determined to be nonirrigable, in order to eliminate nonenterable lands. The office work of preparing the orders of designation in proper form thus became very large and made correspondingly heavy demands upon the time of the available force. As a result of this situation, the recommendations of large general areas for designation, because of the time necessary to prepare the lists, has been greatly curtailed and instead it has been found necessary to request applicants to furnish definite lists of the lands which they propose to enter if designated. These applications and lists are referred to as enlarged homestead petitions. The last year shows an enormous increase in the number of requests of this character received, and while the office force assigned to this work has not been materially increased the number of petitions which have been acted upon is largely in excess of previous years. This result has been accomplished largely by the adoption, as far as practicable, of mimeographed forms in correspondence, the systematizing of office records, and the making of classification maps by which the proper action to be taken upon a petition falling within the area classified can be readily determined.

About the close of the year departmental instructions were so modified as to permit lands to be designated in a body without complete determination of status. This will simplify procedure and facilitate designations for the next fiscal year. The following table indicates the disposition made of the petitions received during the year:

*Action on enlarged-homestead petitions, fiscal year 1912-13.*

State.	Out-standing July 1, 1913	Re- ceived during year.	Designated.		Refused.	Total acted on.	Pending June 30, 1913.
			All.	Part.			
Arizona.....		12	2	3	1	6	6
California.....		9	1	1	3	5	4
Colorado.....	12	117	37	2	21	60	69
Idaho.....	220	412	158	45	124	327	305
Kansas.....		1			1	1	
Montana.....	58	218	26	23	32	81	195
Nevada.....							
New Mexico.....	5	45	2	1	4	7	43
North Dakota.....		971	306	17	44	367	604
Oregon.....	25	79	42	13	7	62	42
Utah.....	8	38	4	1	6	11	35
Washington.....	16	8	1	6	2	9	15
Wyoming.....	5	34	4	4	2	10	29
	349	1,944	583	116	247	946	1,847

#### PUBLIC WATER RESERVES.

During the fiscal year the withdrawal under the act of June 25, 1910, of lands primarily valuable because of springs, streams, or other watering places situated thereon was continued, recommenda-

tions being made on the information procured by field men of the Geological Survey and General Land Office. The following table indicates the progress of this work:

Public water reserves, fiscal year 1912-13.

[In acres.]

State.	Outstand- ing July 1, 1912.	New with- drawals.	Outstand- ing June 30, 1913.
Arizona.....		1,200	1,200
California.....		94	94
Utah.....	23,143	3,160	26,303
Wyoming.....	62,979		62,979
	86,122	4,454	90,576

PUBLICATION BRANCH.

BOOK-PUBLICATION DIVISION.

SECTION OF TEXTS.

The publications of the year consisted of 1 annual report, 1 monograph, 5 professional papers, 26 bulletins, 26 separate chapters from 5 bulletins, 25 water-supply papers, 1 annual report on mineral resources (published also in 56 advance chapters, 20 delivered in 1911-12 and 36 in 1912-13), 18 advance chapters from the annual report on mineral resources for 1912, 4 geologic folios, 2 lists of publications, a pamphlet entitled "Topographic instructions of the United States Geological Survey," a pamphlet entitled "Logarithms and factors for converting latitudes and departures in feet to seconds of latitude and longitude for latitudes 0° to 72°"; charts showing mineral and clay products and the production of coal in the United States to the close of 1911, 2 circulars concerning geologic folios, 15 index map circulars, 60 press bulletins, and 12 monthly lists of new publications. The numbers of these publications in the regular series follow: Thirty-third Annual Report; Monograph LI; Professional Papers 71, 74, 77 to 79, inclusive; Bulletins 471 (published also in 10 advance chapters, 4 delivered in 1911-12 and 6 in 1912-13), 498, 501 to 503, inclusive, 508, 510, 513 to 520 (published also in 13 advance chapters, 3 delivered in 1911-12 and 10 in 1912-13), inclusive, 521 to 524, inclusive, 527, 529, 530 (published also in 18 advance chapters, 13 delivered in 1911-12 and 5 in 1912-13), 4 advance chapters from 531, 532, 534, 535, 537, and 1 advance chapter from 540; Water-Supply Papers 259, 281, 283, 284, 289 to 294, inclusive, 296 to 301, inclusive, 304, 305, 310, 311, and 313 to 317, inclusive; Mineral Resources for 1911 (published also in 56 advance chapters, 20 delivered in 1911-12 and 36 in 1912-13), and 18 advance chapters from Mineral Resources

for 1912; Geologic Folios 184 to 187, inclusive; Lists of Publications, October 1, 1912, and May 1, 1913; Circulars 9-322 (concerning geologic folios) and 9-322, reprint (concerning sale of damaged folios); Index Map Circulars 9-323a to 9-323s, inclusive (except c, d, i, and q); Press Bulletins 63 to 122, inclusive; and Monthly Lists of New Publications 56 to 67, inclusive. Titles and summaries of the publications of the regular series are given on pages 14-27.

The total number of pages in these publications was 18,917. The publications of the year 1911-12 comprised 17,846 pages.

During the year 38,191 pages of manuscript were edited and prepared for printing, and proof sheets for 22,395 final printed pages were read and corrected, this work involving the handling of 4,877 galley proofs and 38,864 page proofs. The corresponding figures for 1911-12 were 48,210 pages of manuscript, 15,677 final printed pages, 5,648 galley proofs, and 30,513 page proofs. Indexes were prepared for 55 publications, covering 14,942 pages; the figures for the previous year were 49 publications and 10,571 pages.

At the close of the fiscal year 7 persons were employed in this section. The water-resources branch has continued to render special assistance in copy preparing and proof reading.

#### SECTION OF ILLUSTRATIONS.

The personnel of the section of illustrations at the close of the year consists of the chief of the section and 8 other draftsmen, 1 clerk, and 1 assistant map printer. The number of illustrations prepared during the year was 2,641, a total below the average in the last few years. Of these, 928 were transmitted to accompany 1 annual report, 16 bulletins (3 in 6, 7, and 13 parts, respectively), 14 water-supply papers, 4 professional papers, 13 separate papers for Mineral Resources 1911 and 1912, 1 departmental circular, and 1 topographic instructions. These illustrations included 229 maps, 464 photographs prepared for reproduction, 370 diagrams and sections, 7 landscape drawings, 1,383 paleontologic drawings and photographs, and 188 miscellaneous pieces. Proofs to the number of 1,394 were received and compared critically. The finished work representing all the illustrations furnished by contractors was examined. This consisted of 189 plates. Eighty-four engraved cuts were reused during the year, and electrotypes of 128 were furnished to outside applicants.

#### SECTION OF DISTRIBUTION.

The section of distribution received during the year 83 new books, 10 reprinted books, 4 folios, 12 geologic maps, 81 new topographic maps, 8 revised maps, 12 photolithographs, and 277 reprints of maps, a total of 487 publications. The total of all editions received was 253,850 books, 14,146 geologic folios, and 1,219,288 maps, a grand total of 1,487,284.

Reprints of the following publications were delivered to the Survey during the fiscal year 1913: Bulletins 491, 520-A, 530-K, 530-P, and 537; Water-Supply Papers 255 and 295, and 3 chapters from Mineral Resources for 1911.

There were distributed 375,213 books, 40,387 folios, and 684,373 maps (including 533,245 maps, 36,530 folios, and 136 books sold), a total of 1,099,973.

The total amount received and turned into the Treasury as the result of sales of publications was \$29,117.66, an increase of \$3,362.44 over the amount received in the fiscal year 1912. The proceeds of sales of topographic and geologic maps was \$25,373.91, of topographic and geologic folios, \$3,099.25, and of books, \$644.50. The sales of maps and folios showed an increase of 22 per cent over the amount received in 1912.

Fifteen persons were employed in this section during the year.

#### DIVISION OF MAP EDITING.

##### SECTION OF GEOLOGIC MAPS.

This section is especially charged with the direction of the publication of the maps and illustrations of the geologic folios. In addition it reviews and criticizes all geologic maps and illustrations used in other reports of the Survey.

Four folios (Nos. 184-187, inclusive), which are listed on page 27, were completed and published during the year. The maps for the Barnesboro-Patton (Pa.), Belleville-Breese (Ill.), Columbus (Ohio), Eastport (Maine), Philipsburg (Mont.), Raritan (N. J.), and Tallula-Springfield (Ill.) folios were completed and will be published with the descriptive texts during the coming year.

The Niagara (N. Y.) and San Francisco (Cal.) folios were well advanced in publication, and the Eureka Springs-Harrison (Ark.), and Van Horn (Tex.) folios were begun. The Castle Rock (Colo.), Colorado Springs (Colo.), Detroit (Mich.), Deming (N. Mex.), Galena-Elizabeth (Ill.), Minneapolis-St. Paul (Minn.), Silver City (N. Mex.), and Tolchester (Md.) folios were recently received in the section and at the close of the year were on file awaiting editing.

The list of folios in course of publication and in preparation for publication, arranged in order of progress, is as follows:

Barnesboro-Patton, Pa. (No. 189).  
 Niagara, N. Y. (No. 190).  
 Raritan, N. J. (No. 191).  
 Eastport, Maine (No. 192).  
 Phillipsburg, Mont.  
 San Francisco, Cal.  
 Belleville-Breese, Ill.  
 Columbus, Ohio.  
 Van Horn, Tex.

Eureka Springs-Harrison, Ark.  
 Minneapolis-St. Paul, Minn.  
 Castle Rock, Colo.  
 Colorado Springs, Colo.  
 Silver City, N. Mex.  
 Tolchester, Md.  
 Deming, N. Mex.  
 Galena-Elizabeth, Ill.  
 Detroit, Mich.



A great number of geologic maps and other illustrations prepared by the section of illustrations for reports other than folios were referred during the year to the chief of this section for criticism and comment.

Three persons are employed in this section.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 167 atlas sheets and maps of special areas were on hand for publication, of which 82 have been published. The accessions during the year were 112, of which 3 have been published. The total number of separate map publications for the year is 101, of which 81 are new engraved sheets, 8 revised sheets (of which 4 were reengraved), and 12 photolithographs of State maps. The following statement shows the comparative status of map editing and publication on June 30 for three years past.

*Progress of map publication for three years ending June 30, 1913.*

	1913	1912	1911
Published during the year.....	101	114	86
In process of engraving.....	89	65	56
Unedited.....	105	102	95

The manuscripts edited during the year comprise 107 topographic atlas sheets and other maps prepared for engraving; 6 State maps on scale of 1:500,000; the 9-sheet contour map of the United States; 37 sheets of plans and profiles of rivers; corrections for 355 engraved maps about to be reprinted; and 152 maps for illustration of 30 Geological Survey reports. The proof read comprises 90 new topographic maps, corrections to 161 old maps, and 6 maps reproduced under contract. The maps for the 21 index circulars of the series 9-323 were revised during the year and all but 6 of the circulars, now in press, were reprinted.

Six men were continuously employed in this work.

DIVISION OF ENGRAVING AND PRINTING.

MAPS, FOLIOS, AND ILLUSTRATIONS.

During the fiscal year 81 new topographic maps were engraved and published, and 12 State maps on the scale of 1 to 500,000 were photolithographed and printed. Corrections were engraved on the plates of 364 sheets. In all, 377 editions of topographic maps were printed, with a total issue of 1,226,237 copies, an increase of 103 editions and 297,665 copies over the previous year.

Several Alaska maps were extensively corrected and readjusted on the plates, amounting in some instances to practical reengraving of



whole plates. The map of Kauai, Hawaii, was completed. The engraving of this map was equivalent to the engraving of about six atlas sheets of average cost. The United States nine-sheet map is in hand for correction. This work requires almost complete reengraving of the contour and drainage plates, in addition to extensive corrections of the culture base, and is about half finished.

Four geologic folios were published during the year, which is two less than the number published in the preceding year. Of the number published this year one (No. 185) is a double folio. Octavo editions of two of this number and of three folios reported last year were published during the present year. Editions and partial editions of folios and octavos amounting to 18,546 copies were printed and delivered. This is a decrease of 11,581 copies for the year.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual report of the Chief of Engineers, United States Army; annual report of the Chief Signal Officer, United States Army; annual report of the Commissioner of Indian Affairs; annual report of the Department of the Interior; annual report of the Governor of Alaska; annual report of the governor of Hawaii; annual report of the War Department, Volume II; report of the Commissioner of Corporations on water-power development in the United States; report of the Commissioner of Corporations on the lumber industry, Part I; Interstate Commerce Commission reports, volume 24; Opinion 1967—Interstate Commerce Commission; Hearings, Isthmian Canal (map of the Canal Zone), Part VI; report on Panama Canal, traffic and tolls; American Ephemeris and Nautical Almanac, 1913; American Ephemeris and Nautical Almanac, 1915; 12 Senate and House documents; bulletins 45, 55, and 64, Bureau of Mines; Bulletin 91, Bureau of Entomology; Bulletins 244 and 260, Bureau of Plant Industry; illustrations for Geological Survey Bulletins 471-I, 501, 502, 503, 510, 520-A, 522, 525, 526, 527, 528, 531-B, 531-C, 534, 535, Professional Paper 74, Water-Supply Papers 294, 304, 313, 318, 319, Mineral Resources—The stone industry in 1911, Thirty-third Annual Report of the Director of the United States Geological Survey, Instructions to topographers. In addition the following separate illustrations were printed and delivered to the Government Printing Office: Diagrams of nine bird reservations and two Indian reservations; Ringlemann's scale for grading density of smoke; Photometric lamp sheet test, Form 174; Protractors, Forms 678 and 678-a; Map of the United States by counties; map of Yosemite Valley; map showing Indian reservations; map of Utah, showing homestead lands; oyster bottoms of the Mississippi east of Biloxi.

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 59 national forests, 33

proclamation diagrams of national forests, map of southern Appalachian region, map of North America (1:10,000), map of national forests—district No. 1, map of United States showing production of lumber by States and kinds in 1910, map of North America—base for atlas of pines, forest trees of North America—36 maps, forest map of Oregon and Washington, map showing hydroelectric development on the watershed of Feather River, map showing hydroelectric development on the watershed of Truckee River, diagram of lookout station protractor, statistical diagram, and illustrations for surveyor's instruction book; for the General Land Office, 1,492 township plats, 775 mineral and homestead plats, 10 State maps showing enlarged homesteads, and other miscellaneous work; for the Post Office Department, 20 diagrams showing floor plans and interior fixtures of mail cars, parcel-post maps of the United States and Hawaiian Islands; for the Office of Indian Affairs, maps of three Indian reservations and other miscellaneous work. Work was also done for the Department of the Interior, Army War College, Isthmian Canal Commission, Department of Commerce and Labor, Bureau of Mines, District of Columbia, Interstate Commerce Commission, Reclamation Service, Department of Justice, Bureau of Education, Smithsonian Institution, Army Service Schools, Howard University, Bureau of Lighthouses, War Department, Alaska Railroad Commission, United States and Canada Boundary Survey, Weather Bureau, Bureau of Standards, and Bureau of Soils.

This work for various branches of the Government amounted to about \$75,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury. Work was also done for the State militia of New York, Massachusetts, Maine, and Vermont; the State geological surveys of Ohio, Illinois, Wisconsin, and Nebraska; Corps of Engineers, United States Army; Hawaiian Volcano Observatory; Yale National Geographic Peruvian Expedition; C. S. Hammond Co., Eckert Lithographic Co., A. B. Graham Co., Matthews-Northrup Works, H. W. Hilleary Co., and American Book Co.; and the money received in payment for the work, amounting to about \$675, was turned into the Treasury of the United States to be credited to miscellaneous receipts.

Of contract and miscellaneous printing of all kinds, the total number of copies delivered was 2,686,970, which required approximately 4,300,000 printings. The total number of copies printed, including topographic maps and geologic folios, was 3,931,753, requiring approximately 10,000,000 impressions. On requisition of the Government Printing Office 495 transfer impressions were made and shipped to contracting printers.

**INSTRUMENT SHOP.**

The work of the instrument shop consisted of repairing surveying, drafting, engraving, stream-gaging, and other instruments and making copper plates and electrotypes. More than 2,000 repairs and overhauls were made, 130,887 square inches of new copper plates were made and 834 square inches were resurfaced, and 12,637 square inches of electrotypes were made.

**PHOTOGRAPHIC LABORATORY.**

The output of the photographic laboratory included 13,424 negatives, of which 9,198 were dry, 3,298 were wet, and 928 were paper, and 29,993 prints, of which 9,966 were maps and diagrams and 20,027 were photographs for illustrations.

**ADMINISTRATIVE BRANCH.****EXECUTIVE DIVISION.**

The work in the executive division was of the same scope as in other years, except that the work of the purchasing clerk, the record of property in Washington, and the work of obtaining stationery, printing and binding, and miscellaneous supplies were transferred to the new division of accounts.

*Mails, files, and records.*—During the year 149,145 pieces of mail were opened and referred, an increase of a little more than 5 per cent over that for the fiscal year 1912. Of this number 2,545 were registered. In addition 87,424 letters were received direct by the other divisions—a total of 236,569 for the Survey.

Of the letters opened in this division 28,162 contained remittances for Survey publications, a slight decrease as compared with the number of similar letters received during the last fiscal year, but the amount of money received, \$30,060.20, shows an increase of \$4,227.18 over that for the fiscal year 1912.

The recording, referring, and filing of correspondence required practically the entire services of five clerks. The number of letters mailed through the division was 99,993, an increase of a little more than 20 per cent over the preceding year. This number does not include the outgoing registered mail, which numbered 17,151 pieces, or 187,526 pieces of letter mail sent direct from the other divisions—a total of 304,670 for the Survey.

*Personnel.*—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 893, compared with 880 at the close of the fiscal year 1912. The total number of changes in the personnel for the year was 835, which included original appointments, separations, promotions, extensions, and changes of status of every

description. Of these, 229 were new appointments, 216 were separations, 304 were promotions, and 4 were reductions.

During the year 13,252 days of annual leave and 2,112 days of sick leave were granted, being about 63 per cent of the amount of annual leave and 11 per cent of the amount of sick leave which it is permissible to grant under the law; also there were granted 3,081 days of leave without pay.

*Express and freight.*—During the year 3,919 pieces of freight and express were handled, of which 963 were outgoing and 2,956 were incoming. There were 403 transportation accounts checked during the year.

*Stationery.*—During the year 6,167 requisitions were filled from stock in the stationery room.

## DIVISION OF ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below, including disbursements up to September 20. The unexpended balances of that date largely represent outstanding obligations.

*Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1913.*

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director .....	\$35,340.00	.....	\$35,340.00	\$34,712.55	\$627.45
Salaries, scientific assistants.....	29,900.00	.....	29,900.00	29,288.88	611.12
Skilled laborers, etc.....	20,000.00	.....	20,000.00	19,432.01	567.99
Gaging streams, etc.....	150,000.00	\$19,980.59	169,980.59	166,270.93	3,709.66
Chemical and physical researches.....	40,000.00	34.46	40,034.46	39,837.79	196.67
Preparation of illustrations.....	18,280.00	.....	18,280.00	16,681.11	1,598.89
Mineral resources of United States.....	75,000.00	5.68	75,005.68	73,807.91	1,197.77
Geologic maps of United States .....	110,000.00	76,393.22	186,393.22	162,238.35	24,154.87
Books for the library.....	2,000.00	.....	2,000.00	1,103.50	896.50
Topographic surveys.....	350,000.00	4,068.14	354,068.14	349,422.67	4,645.47
Geologic surveys.....	300,000.00	38,893.92	338,893.92	330,381.06	8,512.86
Mineral resources of Alaska.....	90,000.00	602.83	90,602.83	77,690.03	12,912.80
Surveying national forests.....	75,000.00	7.15	75,007.15	72,213.34	2,793.81
	1,295,520.00	140,005.99	1,435,525.99	1,373,080.13	62,445.86

The following table gives the classified expenditures by the Survey for the fiscal year:

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1913.

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persona.	Subsistence and care of animals, etc.	Communication service.	Printing, engraving, lithographing, etc.	Furnishing heat, light, power, etc.	Special and miscellaneous services.	Materials.	Stationery, drafting, etc., supplies.
Salaries, office of the Director...	\$34,712.55	\$34,712.55										
Salaries, scientific assistants...	29,288.88	29,288.88										
Skilled laborers, etc.	19,432.01	19,432.01										
Gaging streams, etc.	166,270.93	125,636.08	\$14,753.44	\$769.84	\$7,529.52	\$992.01	\$670.43	\$3,083.15	\$215.50	\$1,704.67	\$669.42	\$1,348.34
Chemical and physical researches.	39,837.79	29,082.03	2,413.06	1,005.26	1,049.18	148.15	65.44	81.84	330.33	920.46	246.62	740.36
Preparation of illustrations.	16,681.11	15,423.17		.70			12.75	961.36		1.50	74.78	132.09
Mineral resources of the United States.	73,807.91	66,482.26	1,846.21	98.70	1,437.30	4.45	444.77	459.04	49.73	410.84	.15	764.21
Geological maps of the United States.	162,238.35	124,770.87	52.93	37.06	37.30		53.50	1,914.31	2,628.97	1,768.40	9,838.40	16,263.20
Books for the library.	1,103.50			6.45								18.40
Topographic surveys.	349,422.67	244,899.32	24,745.78	4,799.48	37,707.18	11,131.05	374.34	6,271.72	165.00	1,856.23	874.80	1,902.52
Geologic surveys.	330,381.06	265,129.94	17,818.62	1,639.70	13,822.75	5,726.17	444.41	4,633.20	139.93	5,546.32	506.32	1,965.05
Mineral resources of Alaska.	77,690.03	56,539.52	8,624.16	1,299.98	2,707.78	535.95	109.61	1,006.48	212.50	337.70	99.66	704.96
Surveying national forests.	72,213.34	43,348.42	4,524.90	1,045.57	9,517.18	4,336.43	43.04	581.94		238.05	343.97	220.44
Total.	1,373,080.13	1,054,145.15	74,779.09	10,701.74	73,808.19	22,874.21	2,218.31	18,993.04	3,741.98	12,784.17	12,654.12	24,059.57

Appropriation.	Fuel.	Mechanics, engineers, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forage and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Rent of buildings.	Fees for licenses, permits, etc.
Salaries, office of the Director.												
Salaries, scientific assistants.												
Skilled laborers, etc.												
Gaging streams, etc.	\$68.63	\$299.34	\$20.95	\$305.56	\$86.89	\$399.54		\$14.85	\$4,953.00	\$106.00	\$3,331.00	\$4.75
Chemical and physical researches.	327.08	66.78	5.20		192.94	599.10		26.45	2,203.35		330.17	
Preparation of illustrations.		3.28							81.48			
Mineral resources of the United States.		1.90	14.58			.27		2.19	966.19		226.00	
Geologic maps of the United States.	427.62	424.49	278.00	.11		8.38		48.41	3,686.40			
Books for the library.	306.28	56.25	33.29	84.25	5,861.48	984.05	\$1.60	115.37	1,079.65	74.10	16.00	65.00
Topographic surveys.	116.14	59.08	48.71	13.60	2,212.27	4,056.20	19.80	141.34	7,097.58		24.65	12.60
Geologic surveys.	182.90	43.78	14.09	196.35	378.97	1,536.14	50.90	36.60	6,304.86		5.00	.25
Mineral resources of Alaska.	89.42	21.10	15.04	49.30	2,966.66	431.79		23.17	3,054.63			
Surveying national forests.									4,435.92			
Total.	1,518.07	976.97	469.86	646.17	11,668.21	7,915.47	72.30	407.38	33,868.06	191.26	4,861.83	82.00

## LIBRARY.

The library receives its increase through purchase, exchange, and gifts, the exchanges being largely in excess of the purchases and gifts. Additions from all sources in 1913 numbered 15,040 and included books, pamphlets, periodicals, and maps. The accessions comprise practically all new literature on geology, paleontology, and mineralogy and such other publications as were considered necessary in the Survey's work. All purchases were made with the approval of the committee on the library.

Current accessions were catalogued as received, full titles being furnished to the Library of Congress for printing on cards. A sufficient number of the printed cards were supplied to the Survey for incorporation in the author and subject catalogues and the shelf list. During the year 4,253 books, 317 pamphlets, and 970 maps were catalogued. There were added to the catalogues 11,579 cards, and 1,005 titles were furnished to the Library of Congress for printing. In addition to the current cataloguing, the work was continued on the full cataloguing of various series in the older portion of the library, including reports and maps of geological surveys of Hungary, Slavonia-Croatia, Galicia, France, Switzerland, and Tasmania (in part), the monographs of the Palaeontological Society of London, public documents, mostly of the Western States, procured for the use of the land-classification board, and maps of the New England, Middle Atlantic, and some of the Southern States.

Printed cards for these various series, as well as for the new geologic books and for all of those catalogued in former years, are now available to librarians. As these cards, marked "Library, U. S. Geol. Survey," are filed in the many public, institutional, and university libraries of the country the information goes abroad that the books described are in the Geological Survey library. This fact accounts in part for the increased number of requests for loans made upon the library by librarians and specialists outside of this city, and also for the increased number of specialists who come here to use the library. While every reasonable effort is made to aid serious workers in availing themselves of the library privileges it is necessary to refuse many requests for outside loans. Many of the books requested are so rare that it is inadvisable to risk sending them away, or are too much used to be conveniently spared. On the other hand, this library has occasionally found it necessary to borrow from out-of-town libraries books which could not be found in Washington. The number of readers in the library during the year was 9,213, and 10,162 books and maps were loaned for use outside.

Up to the present year no scheme for the classification and notation of the maps to harmonize with that of the books had been worked



out, and only an imperfect and incomplete catalogue of the maps existed. The collection consisted of maps received either by exchange or gift and a few which had been purchased. They were rather roughly classified geographically and placed in the drawers. Henry Gannett and J. M. Nickles have thoroughly inspected, arranged, and classified the whole collection and eliminated material that was considered useless. Several thousand maps were transferred to the Library of Congress; others of no value were destroyed. The work of cataloguing the maps of States has progressed through Florida. The collection now contains about 25,000 maps aside from duplicates. The maps issued by the State geological surveys and those of most of the foreign geological surveys have also been completely catalogued.

The bibliography of North American geology for 1911, with 1,266 author entries, was completed and published as Bulletin 524. The bibliography for 1912 (Bulletin 545) is well under way.

The number of letters received was 4,279 and of letters sent 3,140. During the year 2,006 books were collated for binding. The exchange list for book publications of the Survey now includes libraries, institutions, and editorial offices to the number of 313 addresses in the United States and 564 addresses in foreign countries; for geologic folios, 398 addresses, domestic and foreign; and for topographic maps, 486 addresses.

The personnel of the library remained the same throughout the year, comprising the librarian, the assistant librarian, two cataloguers, and three clerks.



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DEPARTMENT OF THE INTERIOR  
UNITED STATES GEOLOGICAL SURVEY  
GEORGE OTIS SMITH, DIRECTOR

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THIRTY-FIFTH ANNUAL REPORT  
OF THE  
DIRECTOR OF THE UNITED STATES  
GEOLOGICAL SURVEY  
TO THE  
SECRETARY OF THE INTERIOR

FOR THE FISCAL YEAR  
ENDED JUNE 30

1914

WASHINGTON  
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# THIRTY-FIFTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

---

GEORGE OTIS SMITH, *Director*.

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The appropriations for the work of the United States Geological Survey for the fiscal year 1913-14 comprised items amounting to \$1,517,920. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

## SPECIAL FEATURES.

### THE PROVINCE OF A FEDERAL SURVEY.

An amendment to the sundry civil appropriation bill was offered in the House of Representatives which, if agreed to by the Senate, would have restricted the geologic work of the Federal Survey to the public lands. As the Senate disagreed to this limitation, the only effect of the proposed legislation was to call attention afresh to the questions raised in the first years of the Survey's history and to reaffirm the policy determined by Congress 32 years ago. The organic act of the Survey, approved March 3, 1879, provided for the work of the new service and defined the duties of the Director of the Geological Survey in these words:

That this officer shall have the direction of the Geological Survey, and the classification of the public lands and examination of the geological structure, mineral resources, and products of the national domain.

Director King saw an ambiguity in the use of the words "national domain," and in the first annual report of the new bureau he stated that "that term was supposed by the first framers of the law to cover the entire United States." He recognized the fact, however, that the term might be held to mean simply the public lands, and with only a small appropriation available to begin the vast work of the new bureau, he chose to take the conservative view and to confine field operations to the lands owned by the Nation rather than to interpret "national domain" as meaning the area within the outer boundaries of the Nation.

At the first session of the following Congress, in June, 1879, an effort was made to extend the authority of the Director of the Federal Survey, and a joint resolution, on motion of Representative Atkins, of Tennessee, chairman of the Committee on Appropriations, was promptly passed by the House amending the organic act of the Survey by providing "that the Director of the Survey may extend his examinations into the States," thus extending the field of the new organization over the whole United States. This legislation was initiated by reason of the construction placed by the law officers of the Interior Department on the words "national domain," these officers contending that the words should apply only to the Territories and States containing public lands, and the object of the legislation was to connect the geology of the national domain, so defined, with that of the States. At the following session of the same Congress the joint resolution was considered by the Senate, but although there was long debate the consideration of this measure was not completed and it thus failed of passage.

It might well have been argued whenever this matter was under debate that the framers of the act establishing the Survey had intended the words "national domain" to have a wider meaning than "public lands," because after these words in the act they wrote a provision prohibiting the Director and members of the Geological Survey from having "personal or private interests in the lands or mineral wealth of the region under survey." Obviously that provision indicates that the work contemplated under the authority given to the new organization included surveys over land in part at least under private ownership.

In 1882, however, all possible ambiguity was removed by a Senate amendment to the pending sundry civil bill whereby the authorization "to continue the preparation of a geological map of the national domain" was made to read "to continue the preparation of a geological map of the United States." After debate, the House, on August 4, concurred in the Senate amendment, which thus authorized the extension of the geologic work of the Survey over the whole country.

In 1906 and 1907 it was ruled in the House of Representatives that the topographic survey of the United States and the preparation of a geological map of the United States are both public works in progress and that legislative provisions looking to the continuance of such work in progress are not subject to a point of order.

In a broad way, the two views expressed in Congress in 1914, as well as in 1879 and 1882, relate simply to the question of the proper function of a Federal investigative service like the Geological Survey with respect to privately owned land.

The function of the Government bureau with relation to publicly owned land is unquestioned, and it has been in recognition of this special function that the land-classification work has been emphasized and expanded until it now constitutes an integral part of the Survey's activity and represents a large share of the current expenditures. Not only is the investigation of all the possible values attaching to lands belonging to the Nation in line with business principles, but the determination of what constitutes the highest use of the undeveloped lands is an allied task of even greater importance—indeed, it is nothing less than a national duty. The Survey's function on the public lands is therefore in no sense a matter for debate, and "the classification of the public lands" in the broadest sense, including the consideration of questions of highest use as well as of lawful disposition, is the special task laid upon this branch of the Government service. The investigations on the public lands directed to the determination of their value may and do go into whatever detail is demanded by the particular resources of this or that tract of land and by the questions to be answered relative to preferable utilization. The Government is the landowner and is interested as a landowner in the natural resources of its real estate.

The function of the Government and the Government bureau with relation to privately owned land must be determined by other facts. The attitude of landlord is here plainly impossible, and land classification in the sense of appraisal and inventory of individual tracts has no place. Presumably in this case the Federal Government is not the one most interested in land value, but rather the interest of the individual or corporation landowner is superior to any concern on the part of the Nation. Upon this sort of premise undoubtedly was based the prohibition in the organic act of the Survey, to the effect that the Director and members of the Survey "shall execute no surveys or examinations for private parties or corporations"—a prohibition which in administrative practice has been construed as aimed against all work done primarily for the benefit of single landowners other than the Government itself, whether such examinations are paid for by the private owners or conducted at public expense.

The prohibition just referred to has never in the history of the Survey been considered as a bar against entry upon privately owned land, or in any sense as a restriction on the extent of the surveys and investigations. Moreover, at least nine States, East as well as West, by special enactment authorize the entry upon private lands to officials of the United States Geological Survey. At the very beginning Director King planned the geologic investigation of the three more important metalliferous mining districts of that day—Lead-

ville, Eureka, and the Comstock—in all of which the lands examined in most detail, both on the surface and underground, were privately owned. But each of these examinations, helpful as it was to the individual mine owners, contributed still more to the development of the whole district as an element in national prosperity and yielded scientific results of great value to the public at large, and indeed the Leadville report as an epoch-making contribution to the study of ore deposits made the world debtor.

The distinction seems obvious. The determinative factor in the whole matter is whether the investigative work on privately owned land yields results that are merely of local and personal interest, or results that are of general and national value. The knowledge of mineral deposits can be gained in large part only by entrance to mines, and thus to private lands. If restricted to public lands, geologists would have no opportunity to advance the study of ore deposits or indeed in many cases to determine the coal value of the publicly owned lands. The detailed examination by the Government geologist of a Leadville mine in 1879, or of a mine in the Yerington district in 1914, is justified only as the facts of ore occurrence observed and the laws of ore genesis determined are found to have broad application in the winning of mineral wealth. This principle applies throughout the whole field of geologic investigation—property lines and State boundaries must be overlooked by the geologist who is attacking a large problem. Land ownership is only an incident when large questions of natural resources are considered.

This leads to another phase of the national character of the United States Geological Survey and its work. The special interest of the Government in its own land being granted, it must be added, as was suggested this year by Representative Sherley at a hearing before the House Appropriations Committee, that “so far as the development of the mineral resources of the country is concerned, it is just as important to know the resources of privately owned land as of Government-owned land.”

Director King, in the first annual report of the Survey, in illustrating the need of Federal investigation, selected iron as a mineral resource of large importance and stated that with the wide distribution and variety of occurrences of iron ores, neither corporations nor individual States could adequately investigate the subject, and he added that only for a few exceptional minerals could private or State enterprise successfully prosecute such work. If it is remembered that in this same report Director King prophesied for the United States a future annual output of mineral products having a value of a billion dollars, and that the present production is two and a half times that amount, it must be conceded that the

desirableness of the Federal scientific investigation of these national resources is even greater now than in 1880.

The crux of the matter lies in the selection of subjects of investigation or of areas for survey as well as the determination of the degree of refinement with which the work should be done. In these decisions the general purpose of the work must serve as a guide, and probably few will oppose the proposition that wherever the investigation serves the general public its prosecution by the National Government is justified, and the greater the public interest in the expected results the larger the claim of that work for preference.

At this time of intensified concern in the highest utilization of every material resource the field of the varied activities of the United States Geological Survey is so broad that it has no disinclination to share the opportunities for research with State organizations of similar character. Provisions that were suggested in the Congressional debates of 30 years ago as necessary to enforce the preference right of individual States to investigate their own territory could not accomplish as much as is now accomplished by either formal or informal cooperative agreement. The cooperation existing between State and Federal geological surveys is both intimate and extensive in the conduct of topographic surveys, stream gaging, and geologic investigations, as well as in the collection of mineral statistics. A total of several hundred thousand dollars annually contributed by each party is the measure of this cooperation. In part the Federal Survey acts as the disburser of State funds in this technical work, in part the State official acts as the representative of the larger organization in local work, and again the National Survey investigates some large interstate problem in behalf of adjoining States. Each of these cooperative methods is effective and prevents duplication of effort, accomplishes standardization of results, and promotes the coordination that secures the general results for the national bureau and the more local benefits for the State organization.

Under the present plan of coordination with the State surveys, which is improved from year to year, it is believed that the United States Geological Survey can most effectively cover the national field of scientific investigations and can contribute to the Nation's advancement to a degree that would be impossible if the Federal bureau were restricted in its operations to the rapidly diminishing remnant of public lands. It is a most conservative statement that never before has the general public been in closer touch with the United States Geological Survey or made larger use of the published or unpublished results of its surveys and investigations.

### SCOPE OF THE WORK.

In the following pages of this administrative report the activities of each branch of the Survey are set forth in detail, but a brief summary will serve to indicate that the United States Geological Survey is national in scope as well as in name.

Geologic investigations were conducted in 47 States, Alaska, Hawaii, and the Canal Zone; topographic surveys were made in 35 States, Alaska, and Hawaii; and stream measurements were continued in 39 States, Alaska, and Hawaii. The total area covered by the geologists in reconnaissance and detailed surveys was more than 75,000 square miles, and the area mapped by the topographers was more than 25,000 square miles, an aggregate area almost nine-tenths that of the United Kingdom. The land-classification work of the Geological Survey last year included reports on an aggregate of 45,000,000 acres, or 70,000 square miles, of public lands, an area of coal, phosphate, oil, and dry-farming lands greater than the area of all the New England States.

In the collection of the statistics of mineral production, the Geological Survey cooperates with the State geologists of 16 States and carries on correspondence with 90,000 producers.

### WORK OF THE YEAR.

#### PUBLICATIONS.

The work of the Geological Survey is reflected chiefly in the publication and distribution of its printed reports and maps. The book publications of the year consisted of 1 annual report, 6 professional papers and 9 separate chapters from 2 professional papers, 28 bulletins and 42 separate chapters from 5 bulletins, 15 water-supply papers and 6 separate chapters from 2 water-supply papers, 1 annual report on Mineral Resources, 1912 (published also in 64 advance chapters, 18 delivered in 1912-13 and 46 in 1913-14), 16 advance chapters from the annual report on Mineral Resources for 1913, 5 geologic folios, 3 pamphlets entitled "Suggestions to authors of papers submitted for publication by the United States Geological Survey," "Service Bulletin, July, 1913," and "Plans and specifications for current-meter gaging stations," 3 charts showing mineral and clay products and coal production, 27 map index circulars and lists of publications, and 55 press bulletins. The total number of pages in these publications was 16,631.

The total of all editions received was 475,925 books, 23,070 geologic folios, and 929,446 maps, a grand total of 1,428,441. There were distributed 585,514 books, 64,543 folios, and 454,654 maps (including 197 books, 59,075 folios, and 338,253 maps sold), a total of 1,105,711, a notable increase in distribution of book publications.



The publications of the year are listed below :

**THIRTY-FOURTH ANNUAL REPORT OF THE DIRECTOR** of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1913. 1913. 183 pages, 2 plates.

A detailed account of the nature and extent of the public service performed by the Geological Survey during the fiscal year 1913, with a statement of the total appropriation made by Congress for the Survey and the allotments for each kind of work. The report contains also notes on special features of the Survey's work, abstracts of the publications of the year, and maps of the United States showing areas covered by topographic and geologic surveys.

**PROFESSIONAL PAPER 76.** The San Franciscan volcanic field, Arizona, by H. H. Robinson. 1913. 213 pages, 14 plates, 36 text figures.

The San Franciscan volcanic field, of which this report treats, covers about 3,000 square miles in the north-central part of Arizona, 50 miles south of the Grand Canyon of the Colorado. It takes its name from San Francisco Mountain, the largest volcano of the group.

The paper deals primarily with the volcanic phenomena of the region and discusses in detail the igneous rocks, considered both individually and as a series of genetically related members. The illustrations include geologic maps and cross sections of parts of the field, profiles of some of the peaks, photomicrographs of typical lava textures, and halftone views.

**PROFESSIONAL PAPER 80.** Geology and ore deposits of the San Francisco and adjacent districts, Utah, by B. S. Butler. 1913. 212 pages, 41 plates, 16 text figures.

A complete geologic report on the San Francisco mining district, in Beaver County, Utah. This district yielded rich returns in the early days of mining in Utah, but its output soon declined, and interest in it was revived only with the development of the Cactus mine in 1903. Each mine in the region is described and suggestions as to prospecting and the author's predictions as to the future of the district are given. The book contains plans and sections of some of the mines and halftone plates illustrating geologic conditions in the district and mineral specimens.

**PROFESSIONAL PAPER 81.** Cretaceous deposits of the eastern Gulf region and Species of *Exogyra* from the eastern Gulf region and the Carolinas, by L. W. Stephenson. 1914. 77 pages, 21 plates, 2 text figures.

The first paper of this book, "Cretaceous deposits of the eastern Gulf region," is a brief statement of the results of investigations made by the author during recent years in the Cretaceous areas of the region named in order to determine the lithologic units worthy of recognition as formations or as members, the lithologic and paleontologic occurrence of these units, and their stratigraphic and age relations. The major lithologic divisions present have all been recognized more or less clearly by previous investigators, but more definite knowledge has been gained of the character and the geologic and geographic boundaries of the several units recognized. The chief additions to the knowledge of the region have been those furnished by a critical study of the organic remains entombed in the deposits, for by this means much light has been thrown on the age relations of the several lithologic units.

The purpose of the second paper, "Species of *Exogyra* from the eastern Gulf region and the Carolinas," is to demonstrate that the representatives



of the marine fossil genus *Exogyra* in the regions under discussion are separable into at least three species, two of which present well-characterized varieties, and to show that these forms are so restricted in range as to give them distinct value in correlation. The author's statements as to the range, distribution, and occurrence of the species and varieties of *Exogyra* in the eastern Gulf region and the Carolinas are based, for the most part, on a study of the collections in the National Museum and on personal field observations.

The book contains tables giving the range of Cretaceous fossils, a geologic map of the Cretaceous deposits of the eastern Gulf region, and reproductions of some of the fossil specimens.

**PROFESSIONAL PAPER 82.** Geology of Long Island, New York, by M. L. Fuller. 1914. 231 pages, 27 plates, 205 text figures.

An exhaustive report on the geology of Long Island, N. Y., including physiography, stratigraphy, and geologic history. New geologic facts developed in the course of the investigations of which this paper is the outcome necessitated a complete revision of the geology of the island as it was known prior to 1903. The investigations along the New York and New England coasts have developed in this eastern region what the author regards as evidence of all but one of the five principal glacial stages recognized in central United States. The Long Island section, which exhibits more clearly than any other the formations of the Pleistocene epoch, is discussed in detail to supply a basis of comparison with similar deposits elsewhere. This systematic discussion is followed by a short tabular summary of the geographic distribution of exposures and by a chapter on correlation, in which the equivalency of the deposits of Long Island to glacial deposits elsewhere, especially to those of the New England coast, is considered. The illustrations consist of topographic and geologic maps of the island and of parts of it, halftone views showing topographic features, and text figures representing geologic sections and profiles.

**PROFESSIONAL PAPER 83.** The Middle Triassic marine invertebrate faunas of North America, by J. P. Smith. 1914. 254 pages, 99 plates.

The first to appear of three volumes on the marine invertebrate faunas of the Lower, Middle, and Upper Triassic of America and essentially a continuation of Professional Paper 40, "The Triassic cephalopod genera of America," which forms a synoptical introduction to the whole faunal work on American Triassic invertebrates. The descriptions of the major groups and genera given in the earlier work are not repeated in Professional Paper 83, but all figures and descriptions of species of Middle Triassic cephalopods that appear in Professional Paper 40 are repeated for convenience of reference. The book is profusely illustrated by halftone plates showing Middle Triassic invertebrates.

**PROFESSIONAL PAPER 84.** The Upper Cretaceous and Eocene floras of South Carolina and Georgia, by E. W. Berry. 1914. 200 pages, 29 plates, 12 text figures.

This paper presents the first systematic account of fossil plants from the Coastal Plain districts of Georgia and South Carolina. Although preliminary in nature, it describes a considerable flora, which clearly demonstrates the Upper Cretaceous age of the deposits in which it is found and which serves to correlate these deposits with the Upper Cretaceous of adjacent States. The illustrations consist mainly of halftone views of Upper Creta-

ceous specimens from the States discussed, restorations of some of the leaves found, and sketch maps showing the distribution in both hemispheres of certain Cretaceous and Recent plant forms.

**PROFESSIONAL PAPER 85.** Shorter contributions to general geology, 1913; advance chapters as follows:

**PROFESSIONAL PAPER 85-A.** The origin of colemanite deposits, by H. S. Gale. 1913. 9 pages.

This paper is the first of a new series to be published by the Survey under the title "Shorter contributions to general geology." The papers included in this series may relate to any phase of geology, such as petrology, paleontology, stratigraphy, glaciology, and structural geology, provided it possesses general interest. The volume is intended as a dignified collection of scientific contributions, each worthy in importance of subject, value of results, and quality of treatment for separate publication as a bulletin or professional paper if it were of sufficient length.

In Professional Paper 85-A the author advances the theory (which has not yet been entirely proved) that colemanite is formed from limestone in veins by replacement of carbonic acid with boric acid.

**PROFESSIONAL PAPER 85-B.** The mud lumps at the mouths of the Mississippi, by E. W. Shaw. 1913. 17 pages, 3 plates, 6 text figures.

In this paper the author considers the origin of the mud lumps in the Delta of the Mississippi so far as it bears on the problem of preventing their formation in places where they are objectionable. The Delta material consists mostly of interlaminated or interbedded thin layers of fine sand and dark-blue clay. According to the author's hypothesis a gentle seaward flow of the delta materials under the land and shallow water near the ends of the passes is taking place. Where this flow is opposed by the comparatively resistant parts of the sediments at the front of the Delta the soft clay is squeezed out and forms the mud lumps. The tendency to flow is assumed to be due to pressure developed by constant additions of sediment.

**PROFESSIONAL PAPER 85-C.** Interpretation of anomalies of gravity, by G. K. Gilbert. 1913. 9 pages, 1 plate, 1 text figure.

A geologist's statement of the possible methods of interpreting the anomalies of gravity—the differences in the observed and computed intensities of gravity at stations established for its measurement.

**PROFESSIONAL PAPER 85-D.** The Jurassic flora of Cape Lisburne, Alaska, by F. H. Knowlton. 1914. 26 pages, 4 plates.

A study of the fossil plants of Cape Lisburne, the bold headland which marks the northern extremity of a land mass projecting into the Arctic Ocean from the western coast of Alaska, 160 miles north of the Arctic Circle, about 300 miles directly north of Nome. The most notable and interesting fact brought out in the study of this flora, as well as that of other parts of Alaska, is that a moist, warm, and perhaps even subtropical climate prevailed in the Arctic regions up to fairly recent geologic time, in striking contrast to the frigid temperature which now makes them barren and inhospitable. The paper contains four plates showing specimens of the flora.

**PROFESSIONAL PAPER 85-E.** Resins in Paleozoic plants and in coals of high rank, by David White. 1914. 32 pages, 6 plates.

This paper presents evidence that anthracite and bituminous coals, as well as those of lower rank, originated as peats, and that the plants from which

the Paleozoic coals were formed were in part resin-bearing—in fact, the resin-bearing elements in the coal-forming floras of the Carboniferous period, to which the bituminous and high-rank coals of most parts of the world belong, are perhaps as numerous as in the floras from which the coals of later epochs were formed. The author points out the general prominence of resins in the Mesozoic and Tertiary coals of low bituminous and inferior ranks and contributes observations as to the disappearance of the resins in these coals in the course of carbonization under regional metamorphism, the resins disappearing at about the stage of carbonization at which the coking quality of the coals is well developed. After reviewing the evidence as to resin and gum secretion in the petrified fragments of Paleozoic plants described by several paleobotanists, he describes and illustrates, by means of selected materials, both common and unique, the abundant resinous matter in Paleozoic coals of medium bituminous or lower ranks.

PROFESSIONAL PAPER 90. Shorter contributions to general geology, 1914; advance chapters as follows:

PROFESSIONAL PAPER 90-A. Geology of the pitchblende ores of Colorado, by E. S. Bastin. 1914. 5 pages, 2 plates.

Part of Professional Paper 90, "Shorter contributions to general geology, 1914." A brief account of the mode of occurrence of pitchblende at Quartz Hill, in Gilpin County, Colo. The great interest that has recently been manifested in radium because of the apparent cures of cancer effected by certain of its emanations makes it desirable to place before the public as promptly as possible all available information in regard to the occurrence of the minerals from which radium may be derived. The present paper is therefore published in advance of a much larger report on the same region in which ore deposits of many other types will be considered.

PROFESSIONAL PAPER 90-B. Erosion and sedimentation in Chesapeake Bay around the mouth of Choptank River. by J. F. Hunter. 1914. 9 pages, 1 plate, 1 text figure.

Results of a test investigation of erosion and sedimentation in the basin of Chesapeake Bay, a region whose topography and hydrography have undergone significant change in the last half century. Although the data here set forth are chiefly of local importance, it is hoped that the study may suggest certain methods that are applicable to a complete study of the bay.

PROFESSIONAL PAPER 90-C. Dike rocks of the Apishapa quadrangle, Colorado, by Whitman Cross. 1914. 15 pages, 4 plates.

A petrographic study of the dike rocks of the Apishapa quadrangle, situated in the plains south of Arkansas River, in Colorado, about 24 miles east of the mountain front. Forty-three dikes have been observed in this quadrangle. They are mostly vertical in position and trend nearly west. According to the current system of classification, most of these rocks are alkali feldspars.

PROFESSIONAL PAPER 90-D. The composition of crinoid skeletons, by F. W. Clarke and W. C. Wheeler. 1914. 5 pages.

A study of the chemical composition of crinoid skeletons in order to determine the function of this class of organisms in the formation of certain sedimentary rocks. The two positive conclusions reached in this investigation are that the recent crinoids are distinctly magnesian and that the proportion of magnesia is dependent in some way on temperature.

**BULLETIN 525.** A geologic reconnaissance of the Fairbanks quadrangle, Alaska, by L. M. Prindle, with a detailed description of the Fairbanks district by L. M. Prindle and F. J. Katz and an account of lode mining near Fairbanks by P. S. Smith. 1913. 220 pages, 22 plates, 20 text figures.

Comprises a general description of the geology and mineral resources of the Fairbanks quadrangle (in the Yukon-Tanana region) and a more detailed description of the geology, mineral resources, and mining development of an area lying adjacent to the town of Fairbanks. Important data are given concerning the nature and geologic relations of the different kinds of bedrock, the character and distribution of the deposits overlying the bedrock, and the occurrence of gold.

**BULLETIN 526.** Coastal glaciers of Prince William Sound and Kenai Peninsula, Alaska, by U. S. Grant and D. F. Higgins. 1913. 75 pages, 40 plates, 18 text figures.

A brief account of an investigation of certain Alaskan glaciers with the intention of supplying some definite information regarding the present positions of the glaciers and the more evident facts of their fluctuations. Comparisons are made with earlier observations to show the advance or retreat of the glaciers examined. The illustrations include maps of the glaciers and the country adjacent to them and views of the glaciers, which constitute some of the most magnificent American scenery that is now accessible to the tourist and nature lover.

**BULLETIN 528.** Geology and ore deposits of Lemhi County, Idaho, by J. B. Umpleby. 1913. 182 pages, 23 plates, 24 text figures.

Discusses the geography, physiography, and geology of Lemhi County as a whole and gives descriptions of 19 mining districts and notes on the mines of each district. The ore deposits may be grouped as gold placers and lodes, lead-silver veins and tabular replacements, copper-bearing gold veins, cobalt-nickel deposits, and tungsten-bearing veins. The total production of the county is about \$20,000,000, two-thirds of which is represented by gold. With the advent of the railroad and modern methods of mining the outlook for a steady growth in the mining industry has become bright. The bulletin contains a topographic sketch map of the county, sections of the veins, claim sheets of some of the districts, and photomicrographs of rock specimens from the deposits.

**BULLETIN 531.** Contributions to economic geology (short papers and preliminary reports), 1911, Part II, Mineral fuels—M. R. Campbell, geologist in charge. 1913. 361 pages, 24 plates, 10 text figures.

This bulletin includes 14 brief reports of two classes—(1) short papers giving comparatively detailed descriptions of deposits of mineral fuels that have economic interest but are not of sufficient importance to warrant a more extended description; (2) preliminary reports on economic investigations the results of which are to be published later in more detailed form. These papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. They have been grouped according to subjects or general regions and each group has been issued as an advance chapter as soon as it was ready. A complete list of the papers included in the volume follows:

The Menifee gas field and the Ragland oil field, Kentucky, by M. J. Munn.  
Oil and gas development in north-central Oklahoma, by R. H. Wood.

Geology and petroleum resources of the De Beque oil field, Colorado, by E. G. Woodruff.

Geologic structure of the Punxsutawney, Curwensville, Houtzdale, Barnesboro, and Patton quadrangles, central Pennsylvania, by G. H. Ashley and M. R. Campbell.

The Williston lignite field, Williams County, N. Dak., by F. A. Herald.

The Little Sheep Mountain coal field, Dawson, Custer, and Rosebud counties, Mont., by G. S. Rogers.

Coal in the Tertiary lake beds of southwestern Montana, by J. T. Pardee.

Coal at Horseshoe Bend and Jerusalem Valley, Boise County, Idaho, by C. F. Bowen.

Lignite in the Goose Creek district, Cassia County, Idaho, by C. F. Bowen.

The Barber coal field, Johnson County, Wyo., by C. H. Wegemann.

The Cerrillos coal field, Santa Fe County, N. Mex., by W. T. Lee.

The Coaldale coal field, Esmeralda County, Nev., by J. H. Hance.

Coal resources of Cowlitz River valley, Cowlitz and Lewis counties, Wash., by A. J. Collier.

Miscellaneous analyses of coal samples from various fields of the United States.

**BULLETIN 533.** Geology of the Nome and Grand Central quadrangles, Alaska, by F. H. Moffit. 1913. 140 pages, 12 plates, 13 text figures.

This bulletin describes the geology of the Nome and Grand Central quadrangles, in the south-central part of Seward Peninsula, Alaska, emphasizing especially their mineral resources. Mining for gold is the chief industry and placer deposits are more numerous than lodes. The illustrations include topographic and geologic maps of each of the quadrangles, sketch maps of certain economically important districts, and sections of gravel deposits.

**BULLETIN 536.** The Noatak-Kobuk region, Alaska, by P. S. Smith. 1913. 160+x pages, 15 plates, 1 text figure.

The first published account of the geology and resources of the Noatak-Kobuk region, which is adjacent to two of the largest streams of Alaska. An outline of scientific exploration in northern Alaska is given, but the report treats mainly of the economic geology and the geographic features that have important control of the development of the mining industry, which is carried on chiefly for the recovery of placer gold. The book contains also some valuable information on the extent of existing glaciers and on the former period of glaciation, and is illustrated by topographic and geologic maps, a map showing distribution of timber in the region, and halftones representing typical geologic features.

**BULLETIN 538.** A geologic reconnaissance of the Circle quadrangle, Alaska, by L. M. Prindle. 1913. 82 pages, 13 plates, 2 text figures.

A sketch of the geography and geology of the Yukon-Tanana region in general and of the Circle quadrangle in particular. This quadrangle covers about 17,000 square miles and includes several districts that have been productive of placer gold. The report describes especially the placers of the Birch Creek district and of the creeks tributary to the Yukon above Circle. It contains topographic and geologic maps of the quadrangle and halftone plates showing geologic and mining features.

**BULLETIN 539.** Some ore deposits in northwestern Custer County, Idaho, by J. B. Umpleby. 1913. 104 pages, 10 plates, 4 text figures.

This report sets forth the results of a short reconnaissance in the Loon Creek, Yankee Fork, and Bay Horse mining districts, situated in the north-

western part of Custer County, Idaho. The area includes several promising ore deposits and a few mines where large quantities of ore are blocked out, awaiting more advantageous transportation facilities.

The area is first treated as a unit in order to bring out the broader relations, and then the three districts are taken up separately, thus making the report equally valuable to the student of the general subject of ore deposits and to the person interested in a particular district.

The book is illustrated by topographic and geologic sketch maps and plates showing views of the mines and specimens of ore.

**BULLETIN 540.** Contributions to economic geology (short papers and preliminary reports), 1912, Part I, Metals and nonmetals except fuels—David White, chief geologist. 1914. 563 pages, 11 plates, 60 text figures.

This bulletin is made up of 30 brief reports on investigations of mineral deposits except fuels in the United States in 1912. The papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. They have been grouped according to the subjects or localities treated, and each group has been issued as an advance chapter as soon as it was ready. A complete list of the papers included is given below. The volume contains also lists of Survey publications on the several classes of mineral deposits.

Auriferous gravels in the Weaverville quadrangle, California, by J. S. Diller.

Gold lodes of the Weaverville quadrangle, California, by H. G. Ferguson.

Mineral resources of the Inyo and White mountains, California, by Adolph Knopf.

The ore deposits of Kirwin, Wyo., by D. F. Hewett.

Copper deposits near Superior, Ariz., by F. L. Ransome.

Copper deposits of the White Mesa district, Ariz., by J. M. Hill.

Economic geology of the region around Mullan, Idaho, and Saltese, Mont., by F. C. Calkins and E. L. Jones, jr.

The lead-silver deposits of the Dome district, Idaho, by J. B. Umpleby.

The Yellow Pine mining district, Clark County, Nev., by J. M. Hill.

Preliminary report on the red iron ores of east Tennessee, northeast Alabama, and northwest Georgia, by E. F. Burchard.

Titaniferous magnetite beds on the Blackfeet Indian Reservation, Mont., by Eugene Stebinger.

Recent discoveries of "Clinton" iron ore in eastern Wisconsin, by F. T. Thwaites.

Alunite in granite porphyry near Patagonia, Ariz., by F. C. Schrader.

Alunite at Bovard, Nev., by F. C. Schrader.

The Aberdeen granite quarry, near Gunnison, Colo., by J. F. Hunter.

Ornamental marble near Barstow, Cal., by R. W. Pack.

Clay in northwestern Montana, by C. M. Bauer.

Phosphate deposits in southwestern Virginia, by G. W. Stose.

Notes on the Quaternary lakes of the Great Basin, with special reference to the deposition of potash and other salines, by H. S. Gale.

Prospecting for potash in Death Valley, Cal., by H. S. Gale.

Salt, borax, and potash in Saline Valley, Inyo County, Cal., by H. S. Gale.

Potash tests at Columbus Marsh, Nev., by H. S. Gale.

Sodium sulphate in the Carrizo Plain, San Luis Obispo County, Cal., by H. S. Gale.

Borate deposits in Ventura County, Cal., by H. S. Gale.

Potash in western saline deposits, by J. H. Hance.

Niter near Melrose, Mont., by R. W. Richards.



Sulphur deposits in Park County, Wyo., by D. F. Hewett.

Late developments of magnesite deposits in California and Nevada, by H. S. Gale.

Celestite deposits in California and Arizona, by W. C. Phalen.

New areas of diamond-bearing peridotite in Arkansas, by H. D. Miser.

**BULLETIN 541.** Contributions to economic geology (short papers and preliminary reports), 1912, Part II. Mineral fuels; advance chapters as follows:

**BULLETIN 541-A.** Oil and gas in the northern part of the Cadiz quadrangle, Ohio, by D. D. Condit; Gas from mud lumps at the mouths of the Mississippi, by E. W. Shaw. 1913. 15 pages, 1 plate.

The first paper discusses the oil and gas prospects of a part of eastern Ohio and contains a map of the region discussed showing structure contours on top of the Berea sand, whence comes practically all of the oil in this part of the State.

The second paper sets forth the principal facts bearing on the possible existence of valuable accumulations of gas in the mud lumps at the mouths of the Mississippi. These mud lumps are great swellings of soft bluish-gray clay which rise in the shallow water near the mouths of the river, commonly forming islands with a surface extent of an acre or more and a height of 5 to 10 feet.

**BULLETIN 541-B.** Structure of the Fort Smith-Poteau gas field, Arkansas-Oklahoma; The Glenn oil and gas pool and vicinity, Oklahoma, by C. D. Smith. 1913. 28 pages, 2 plates, 1 text figure.

These papers discuss briefly the fields named, pointing out the relation existing between accumulations of oil and gas and the geologic structure as shown by the attitude of surface strata, with a view to ascertaining some general relations that may be applicable to fields in Arkansas and Oklahoma which are yet untouched or only partly developed.

**BULLETIN 541-C.** The Douglas oil and gas field, Converse County, Wyo., by V. H. Barnett; The Shoshone River section, Wyoming, by D. F. Hewett. 1914. 67 pages, 2 plates, 2 text figures.

The first paper gives the results of an investigation of the Douglas oil and gas field in order to ascertain the mineral resources, especially oil, gas, and coal, for the purpose of classifying the land by legal subdivisions into mineral land and nonmineral land. A secondary object was to determine the geologic structure, the various formations involved, and the conditions which have resulted in the accumulation of oil and gas.

The second paper describes the geology of the area adjacent to Shoshone River, which rises among the ridges of the Absaroka Range in northwestern Wyoming and flows northeastward to a point near the Montana line, where it empties into Bighorn River. With a view of using it as a guide in the study and mapping of a large area south of the river in which the geologic structure is favorable for the accumulation of oil and gas, the Mesozoic section along the river east of the Rattlesnake Mountain fold has been accurately measured and examined in greater detail than is customary in such investigations.

**BULLETIN 541-D.** Oil and gas near Green River, Grand County, Utah, by C. T. Lupton; Petroleum near Dayton, N. Mex., by G. B. Richardson. 1913. 27 pages, 1 plate, 1 text figure.

The first paper gives the results of a detailed investigation of the oil and gas resources near Green River, Grand County, Utah. The investigation



showed that, while traces of oil and small pockets of gas have been encountered in some of the wells, there are no anticlines or domes in which large quantities of oil or gas might be expected to collect.

The second paper discusses the possible occurrence of a commercially important quantity of petroleum near Dayton, N. Mex., in the Pecos Valley.

**BULLETIN 541-E.** Reconnaissance of the Barstow-Kramer region, California, by R. W. Pack. 1913. 16 pages, 1 plate.

The reconnaissance survey described in this paper was made in order to determine whether or not oil might be expected to occur in the Barstow-Kramer region in commercially valuable quantities. As a result of his investigation the author concludes that the northern part of the Mohave Desert between Barstow and Mohave offers practically no promise of becoming a productive oil field and that further drilling will prove a waste of money.

**BULLETIN 541-G.** The Cannonball River lignite field, North Dakota, by E. R. Lloyd. 1914. 51 pages, 2 plates, 1 text figure.

A detailed account of a survey of the Cannonball River lignite field, comprising a discussion of the geography and geology of the field and the distribution, physical properties, and mining development of the lignite and descriptions, by townships, of the beds.

**BULLETIN 541-H.** Coal and lignite fields in Montana, papers by C. M. Bauer, G. S. Rogers, and C. F. Bowen. 88 pages, 7 plates, 3 text figures. Contains:

Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont., by C. M. Bauer.

Geology and coal resources of the area southwest of Custer, Yellowstone and Bighorn counties, Mont., by G. S. Rogers.

Coal discovered in a reconnaissance survey between Musselshell and Judith, Mont., by C. F. Bowen.

The Cleveland coal field, Blaine County, Mont., by C. F. Bowen.

The Big Sandy coal field, Chouteau County, Mont., by C. F. Bowen.

**BULLETIN 541-I.** Coal fields in Idaho, Washington, and Oregon. Papers by E. G. Woodruff and C. E. Leshner. 1914. 42 pages, 4 plates, 4 text figures. Contains:

The Horseshoe Creek district of the Teton Basin coal field, Fremont County, Idaho, by E. G. Woodruff.

The Glacier coal field, Whatcom County, Wash., by E. G. Woodruff.

The Eden Ridge coal field, Coos County, Oreg., by C. E. Leshner.

**BULLETIN 541-K.** Analyses of coal samples from various fields in the United States. 1914. 38 pages.

Contains tables, arranged by States and counties, giving analyses and descriptions of all coal samples collected by the United States Geological Survey during the year 1913.

**BULLETIN 542.** Mineral resources of Alaska: report on progress of investigations in 1912, by A. H. Brooks and others. 1913. 308+x pages, 10 plates, 7 text figures.

A collection of 12 brief reports on the work of the Geological Survey in Alaska during 1912. Illustrated by a map of Alaska showing railway routes from the Pacific seaboard to the Yukon and Kuskokwim, geologic sketch maps of several of the mining regions, and hydrographs showing the daily dis-

charge of Yukon and Fortymile rivers. The titles of the papers are given below :

Administrative report, by A. H. Brooks.

The mining industry in 1912, by A. H. Brooks.

Marble resources of Ketchikan and Wrangell districts, by E. F. Burchard.

The McKinley Lake district, by Theodore Chapin.

Mining in Chitina Valley, by F. H. Moffit.

Mineral deposits of the Ellamar district, by S. R. Capps and B. L. Johnson.

Mineral deposits of Kodlak and the neighboring islands, by G. C. Martin.

Lode mining near Fairbanks, by P. S. Smith.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth and R. W. Davenport.

Water supply of the Yukon-Tanana region, 1912, by C. E. Ellsworth and R. W. Davenport.

Gold placers of the Ruby district, by H. M. Eakin.

Gold placers of the Innoko-Iditarod region, by H. M. Eakin.

**BULLETIN 543.** Geology and geography of a portion of Lincoln County, Wyo., by A. R. Schultz. 1914. 141 pages, 11 plates, 8 text figures.

Describes in detail the geography and geology, both historical and economic, of an area of about 2,500 square miles in Lincoln County, Wyo. This county is in the extreme western part of the State and until 1912 was a part of Uinta County. Coal, petroleum, gold, and phosphate occur in the area, but mining has not progressed far beyond the prospecting stage. The bulletin is illustrated by topographic and geologic maps of the area, sections of coal beds, and halftone plates showing views of geologic interest.

**BULLETIN 545.** Bibliography of North American geology for 1912, with subject index, by J. M. Nickles. 1913. 192 pages.

A list, arranged alphabetically by authors' names, of publications on the geology of the continent of North America and adjacent islands, also Panama and the Hawaiian Islands, published in 1912. The work is indexed and contains lists of chemical analyses reported and minerals, rocks, and formations described.

**BULLETIN 546.** Mineral resources of southwestern Oregon, by J. S. Diller. 1914. 147 pages, 11 plates, 26 text figures.

Describes briefly the geography and geology of southwestern Oregon, in the vicinity of the Klamath Mountains, which has been known since its earliest history as a region of important mineral resources. It abounds in gold and coal, and mining has progressed steadily since these resources were first discovered. The report describes the lode and placer mines and prospects in detail as well as the several coal fields and is illustrated by maps showing the location of the gold-quartz mines and geologic sections of some of the mines and coal fields.

**BULLETIN 547.** Reconnaissance of the Grandfield district, Oklahoma, by M. J. Munn. 1914. 85 pages, 5 plates.

This report discusses the general geologic conditions in the Grandfield district (which embraces about 360 square miles in Tillman and Cotton counties, Okla.), especially those that furnish a clue to the possible location of oil and gas pools. The district was examined in the hope that geologic work in advance of drilling might enable oil and gas prospectors to place their test wells most favorably and so avoid losses involved in drilling dry holes and at the same time obtain the best tests for the presence of oil and gas in

paying quantities. The illustrations include geologic sketch maps of the Grandfield district and of Oklahoma and northern Texas and sections of deep wells in this general region.

**BULLETIN 551. Results of triangulation and primary traverse, 1911 and 1912—**

R. B. Marshall, chief geographer. 1914. 396 pages, 2 plates.

Gives the results of triangulation and primary traverse in the United States for the years 1911 and 1912, listing 367 triangulation stations and 7,308 primary traverse stations, nearly all on United States standard datum. Includes a map showing the condition of astronomic location and primary control to January 1, 1913, and a halftone plate showing Geological Survey station marks.

**BULLETIN 552. Results of triangulation and primary traverse in Ohio, 1898 to**

1911, inclusive—R. B. Marshall, chief geographer. 1914. 232 pages, 2 plates.

Lists 182 triangulation stations and 5,416 primary traverse stations in Ohio, all on United States standard datum. Illustrated by a map showing condition of primary control to January 1, 1912, and a halftone plate showing Geological Survey station marks.

**BULLETIN 553. Results of spirit leveling in Illinois, 1911 to 1913, inclusive—**

R. B. Marshall, chief geographer. 1914. 110 pages, 1 plate.

**BULLETIN 554. Results of spirit leveling in Kentucky, 1898 to 1913, inclusive—**

R. B. Marshall, chief geographer. 1914. 184 pages, 1 plate.

**BULLETIN 555. Results of spirit leveling in Indiana, 1897 to 1911, inclusive—**

R. B. Marshall, chief geographer. 1913. 51 pages, 1 plate.

**BULLETIN 556. Results of spirit leveling in Oregon, 1896 to 1913, inclusive—**

R. B. Marshall, chief geographer. 1914. 175 pages, 1 plate.

**BULLETIN 557. Results of spirit leveling in the State of Washington, 1896 to**

1913, inclusive—R. B. Marshall, chief geographer. 1914. 178 pages, 1 plate.

**BULLETIN 558. Results of spirit leveling in Wyoming, 1896 to 1912, inclusive—**

R. B. Marshall, chief geographer. 1914. 148 pages, 1 plate.

**BULLETIN 564. Results of spirit leveling in Oklahoma, 1895 to 1912, inclusive—**

R. B. Marshall, chief geographer. 1914. 119 pages, 1 plate.

**BULLETIN 571. Results of spirit leveling in Kansas, 1896 to 1913, inclusive—**

R. B. Marshall, chief geographer. 1914. 47 pages, 1 plate.

Reports on precise and primary leveling in the States mentioned, showing the exact altitude of a great number of places. The work in Illinois and Kentucky, and part of that in Oklahoma, Oregon, and Washington was done in cooperation with the States. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

**BULLETIN 575. Geology of the Standing Rock and Cheyenne River Indian reser-**

vations, North and South Dakota, by W. R. Calvert, A. L. Beekly, V. H. Barnett, and M. A. Pishel. 1914. 49 pages, 8 plates, 1 text figure.

A compilation of the information obtained by three parties of Survey geologists sent to examine the Standing Rock and Cheyenne River Indian reservations in order to ascertain definitely the coal resources of the area. The surplus and unallotted lands in these reservations were to be sold or allotted to homesteaders, and it was necessary that their mineral value be known. The bulletin describes the geology of the area in detail and discusses its underground water and other mineral resources, which comprise a very small

amount of impure lignite, clay that might be utilized for brick, and gravel for road building. The report concludes with the statement that, as the quantity of lignite is not sufficient to justify the establishment of an extensive mining plant, mining will continue to be limited (as it now is) to a few small prospects where the fuel is taken out for local consumption. The illustrations include a geologic map of the reservations, a map showing outcrops of coal, and sections showing thickness of beds.

**BULLETIN 580.** Contributions to economic geology (short papers and preliminary reports), 1913, Part I, Metals and nonmetals except fuels; advance chapters as follows:

**BULLETIN 580-A.** The Darwin silver-lead mining district, California, by Adolph Knopf. 1914. 18 pages, 3 text figures.

Describes briefly the geologic features of the Darwin district, including the ore deposits, mines, and prospects. This district has yielded between \$2,000,000 and \$3,000,000 in argentiferous lead.

**BULLETIN 580-B.** Notes on the Unaweep copper district, Colorado, by B. S. Butler. 1914. 7 pages.

Notes the more important geologic features bearing on the ore deposits of the Unaweep district, visited in September, 1913. Copper is the main valuable metal of the district, though the ores contain some gold and silver.

**BULLETIN 580-C.** Some cerusite deposits in Custer County, Colo., by J. F. Hunter. 1914. 13 pages, 2 text figures.

Consists of notes based on information gained during a two-day visit in June, 1913, to the zone of cerusite deposits along Oak Creek in the vicinity of Ilse, Custer County. Includes a geologic section across the cerusite belt and a plan of the Terrible mine—the principal mine of the district.

**BULLETIN 580-D.** The Grand Gulch mining region, Mohave County, Ariz., by J. M. Hill. 1914. 20 pages, 5 text figures.

Discusses briefly the economic conditions, such as transportation, water, climate, timber, and labor in the Grand Gulch region, and describes the equipment, development, and ores of the Grand Gulch and Bronze L mines.

**BULLETIN 580-E.** A new gypsum deposit in Iowa, by G. F. Kay. 1914. 6 pages, 1 text figure.

Tells of a recently discovered gypsum deposit in the southern part of the town of Centerville, Appanoose County, Iowa. The evidence indicates that the deposit may be extensive, and the gypsum is of good quality. The deposit is well located with regard to fuel and transportation, and it is fair to assume that if gypsum products were made in this part of the State a good market for such products could soon be developed.

**BULLETIN 581.** Contributions to economic geology (short papers and preliminary reports), 1913, Part II, Mineral fuels; one advance chapter, namely:

**BULLETIN 581-A.** Oil shale of northwestern Colorado and northeastern Utah, by E. G. Woodruff and D. T. Day. 1914. 21 pages, 1 plate.

An account of a reconnaissance survey of a part of the area occupied by the Green River formation in Utah and Colorado in order to determine the geographic distribution and thickness of the oil shale which occurs there. The results of the survey indicate that the shale contains a large reserve supply of oil which sooner or later will be used to supplement the product of the well-known fields.

**BULLETIN 585.** Useful minerals of the United States, compiled by Samuel Sanford and R. W. Stone. 1914. 250 pages.

The material in this bulletin is arranged in two distinct parts. The first part gives concisely the location, by States, of the principal deposits of useful minerals. The States are arranged alphabetically and under each State the minerals found there are given, also in alphabetic sequence. The second part is virtually an index to the first part. It consists of a glossary of more than 425 minerals, showing the composition and character of each mineral and the location, by States, of its principal deposits.

**WATER-SUPPLY PAPER 302.** Surface water supply of the United States, 1911, Part II, South Atlantic coast and eastern Gulf of Mexico drainage basins, prepared under the direction of M. O. Leighton by M. R. Hall and C. H. Pierce. 1913. 90 pages, 4 plates.

**WATER-SUPPLY PAPER 303.** Surface water supply of the United States, 1911, Part III, The Ohio River basin, prepared under the direction of M. O. Leighton by A. H. Horton, M. R. Hall, and H. J. Jackson. 1913. 112 pages, 4 plates.

**WATER-SUPPLY PAPER 306.** Surface water supply of the United States, 1911, Part VI, Missouri River basin, prepared under the direction of M. O. Leighton by W. A. Lamb, W. B. Freeman, and Raymond Richards. 1914. 374 pages, 4 plates.

**WATER-SUPPLY PAPER 307.** Surface water supply of the United States, 1911, Part VII, Lower Mississippi River basin, prepared under the direction of M. O. Leighton by W. B. Freeman and H. J. Dean. 1913. 90 pages, 4 plates.

**WATER-SUPPLY PAPER 308.** Surface water supply of the United States, 1911, Part VIII, Western Gulf of Mexico, prepared under the direction of M. O. Leighton by W. W. Follett, W. B. Freeman, and G. K. Larrison. 1913. 117 pages, 4 plates.

**WATER-SUPPLY PAPER 309.** Surface water supply of the United States, 1911, Part IX, Colorado River basin, prepared under the direction of M. O. Leighton by Robert Follansbee, W. B. Freeman, and G. C. Baldwin. 1914. 266 pages, 4 plates.

These reports present briefly the results of measurements of flow made in streams in the drainage basins named during the calendar year 1911. Data for each gaging station are given under the following heads: Location, Records available, Drainage area of stream, Gage, Channel, Discharge measurements, Accuracy, and Cooperation. The books also contain tables giving gage heights and daily and monthly discharges at each station, lithographed maps showing the mean annual precipitation and run-off in the United States, and halftone plates representing typical gaging stations and current meters.

**WATER-SUPPLY PAPER 318.** Water resources of Hawaii, 1909-1911, prepared under the direction of M. O. Leighton by W. F. Martin and C. H. Pierce. 1913. 552 pages, 15 plates, 4 text figures.

This volume contains results of measurements of the flow of certain streams and ditches in the Territory of Hawaii made during the period 1909 to 1911, inclusive, an account of the factors that affect the flow, and a brief summary of the general conditions influencing the economic development and use of the surface waters. The illustrations consist of drainage maps of some of the islands, showing location of gaging stations, diagrams explaining features of discharge, and halftone plates showing typical gaging stations, waterfalls, and mountain streams. The volume contains also an appendix comprising notes

on the pronunciation and meaning of Hawaiian geographic names and a gazetteer.

**WATER-SUPPLY PAPER 319.** Geology and ground waters of Florida, by G. C. Matson and Samuel Sanford. 1913. 444 pages, 17 plates, 7 text figures.

A detailed report on the geography, stratigraphy, and geologic history of Florida with especial reference to its underground water. The water supply of each county, as well as of the State as a whole, is discussed with reference to its source, quality, and development, and tables giving interesting data about typical wells of the State are added to many of the county descriptions. The illustrations include a general topographic and geologic map of Florida, a map of its Pleistocene terraces, a diagram showing the importance of choosing proper locations for wells, and halftones showing features of geologic interest.

**WATER-SUPPLY PAPER 320.** Geology and water resources of Sulphur Spring Valley, Arizona, by O. E. Meinzer and F. C. Kelton, with a section on agriculture by R. H. Forbes. 1913. 231 pages, 15 plates, 32 text figures.

Discusses the physiography, drainage, and geology of Sulphur Spring Valley in detail, with especial reference to rainfall, artesian conditions, and the occurrence, level, and quality of ground waters. In the section on agriculture Mr. Forbes explains the several methods of farming employed in the valley and concludes that the most certain of these is dry farming supplemented by pumped water supply. The pumping plants in use are fully described. The report contains maps showing the geology and vegetation, depth to water, elevation of ground-water table, and approximate amounts of dissolved solids and certain chemicals in the ground waters in the valley, as well as diagrams showing the daily, monthly, and annual rainfall and deviations from the average rainfall.

**WATER-SUPPLY PAPER 322.** Surface water supply of the United States, 1912, Part II, South Atlantic coast and eastern Gulf of Mexico basins, by W. E. Hall and C. H. Pierce. 1914. 98 pages, 4 plates.

**WATER-SUPPLY PAPER 323.** Surface water supply of the United States, 1912, Part III, Ohio River basin, by A. H. Horton, W. E. Hall, and H. J. Jackson. 1914. 118 pages, 2 plates.

**WATER-SUPPLY PAPER 324.** Surface water supply of the United States, 1912, Part IV, St. Lawrence River basin, by C. C. Covert, A. H. Horton, and W. G. Hoyt. 1914. 149 pages, 3 plates.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1912. Data for each gaging station are given under the following heads: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books also contain tables giving gage heights and daily and monthly discharges at each station, and halftone plates representing typical gaging stations and current meters.

**WATER-SUPPLY PAPER 333.** Ground water in Boxelder and Tooele counties, Utah, by Everett Carpenter. 1913. 90 pages, 2 plates, 9 text figures.

The area covered by this report includes Boxelder County and the eastern part of Tooele County, Utah, and some small tracts in southern Idaho, comprising in all about 9,500 square miles. Insufficient rainfall and the rapid settling of the country created a demand for an investigation to determine the feasibility of irrigating by the use of underground water, in response to



which this report was prepared. The physiography, geology, climate, and vegetation are briefly described, the quality of the ground water is discussed, and a detailed account of the water supply in the several valleys of the district is given. The book also contains information regarding watering places on the routes of travel, maps of the areas investigated, and diagrams relating to rainfall.

**WATER-SUPPLY PAPER 334.** The Ohio Valley flood of March-April, 1913 (including comparisons with some earlier floods), by A. H. Horton and H. J. Jackson. 1913. 96 pages, 22 plates.

This paper gives a brief history of the flood in the Ohio Valley in the spring of 1913 and such data concerning this and previous floods in the same region as could be prepared with the records and funds at present available. The causes of these floods have been (1) excessive rainfall, (2) the rapid melting of accumulated snow, (3) the failure of reservoirs, (4) the forming and breaking of ice jams, and (5) the breaking of levees. The report suggests what can and should be done in collecting the hydrometric data necessary for a complete report upon the floods that menace the Ohio Valley, to the end that a definite decision may be reached as to the best and most economical means of preventing damage by floods. It contains tables showing gage heights, precipitation, and summaries of flood-flow records at stations on Ohio River; also numerous views of the flooded district at the time of the disaster.

**WATER-SUPPLY PAPER 337.** The effects of ice on stream flow, by W. G. Hoyt. 1913. 77 pages, 7 plates, 18 text figures.

This paper presents the available information on the methods of ascertaining the winter flow of streams in localities cold enough for the formation of ice. By discussing the factors that influence the run-off during periods of low temperature, the varieties of ice and their effect on the applicability of the laws of open-channel flow, and the collection and interpretation of winter records, the author seeks to standardize the methods of collecting records of stream flow during the ice-obstructed periods as those for open-water periods have been standardized. As the minimum flow of a stream—the flow that determines the success or failure of most hydraulic works—is most likely to occur during periods when the stream is ice covered and the temperature is low, accurate information concerning this flow is essential for any project that contemplates the continuous use of the stream. The illustrations include numerous diagrams showing the relation between temperature, gage height, and discharge on certain streams, relation between open-water curve and ice measurements, distribution of velocity under ice cover, and other problems incidental to the collection of records of winter flow.

**WATER-SUPPLY PAPER 340.** Stream-gaging stations and publications relating to water resources, 1885–1913, compiled by B. D. Wood; advance chapters as follows:

**WATER-SUPPLY PAPER 340–A.** Part I, North Atlantic coast drainage basins. 1914. 19+xii pages.

**WATER-SUPPLY PAPER 340–B.** Part II, South Atlantic coast and eastern Gulf of Mexico drainage basins. 1914. 10+xix pages.

The first two parts of Water-Supply Paper 340, a directory of Survey stream-gaging stations and publications relating to water resources of the United States. Each part will contain a list of all gaging stations maintained in the section named in its title and an annotated list of publications issued by the United States Geological Survey relating specifically to



that section, as well as a similar list of reports that are of general interest, covering a wide range of hydrologic subjects, and brief references to reports published by State and other organizations.

Water-Supply Paper 340-A pertains to the north Atlantic coast section, which includes the area drained by streams flowing into the Atlantic Ocean from St. John River, Me., to York River, Va.

Water-Supply Paper 340-B pertains to the south Atlantic coast and eastern Gulf of Mexico basins, which include the area drained by streams flowing into the Atlantic Ocean and Gulf of Mexico from York River, Va., to Pearl River, Miss.

**WATER-SUPPLY PAPER 345.** Contributions to the hydrology of the United States, 1914; advance chapters as follows:

**WATER-SUPPLY PAPER 345-A.** Preliminary report on ground water for irrigation in the vicinity of Wichita, Kans., by O. E. Meinzer. 1914. 9 pages.

The first paper of an annual volume to be issued in parts by the Geological Survey in order to furnish early information of the results of investigations made by its hydraulic engineers and geologists on the water supply of various sections of the country.

Water-Supply Paper 345-A gives an outline of the geology of the Wichita region with especial reference to its water resources. It contains a table of partial analyses of the ground waters in the vicinity of Wichita.

**WATER-SUPPLY PAPER 345-B.** Ground water for irrigation in the vicinity of Enid, Okla., by A. T. Schwennesen, with a note on ground water for irrigation in the Great Plains, by O. E. Meinzer. 1914. 23 pages, 1 plate.

The investigation of which Water-Supply Paper 345-B is the result shows that the water supply near Enid is derived chiefly by the percolation of the rain which falls in that vicinity, that although this supply is not large it is to some extent replenished by every heavy rainstorm, and that if it is withdrawn in moderate quantities for irrigation it will add materially to the agricultural production of the community. The investigation also shows the wisdom of thoroughly testing irrigation on a small scale before making heavy expenditures for large power plants. The paper is accompanied by a map of the vicinity of Enid, showing ground-water conditions.

**WATER-SUPPLY PAPER 345-C.** Underground water of Luna County, N. Mex., by N. H. Darton, with results of pumping tests by A. T. Schwennesen. 1914. 16 pages, 1 plate.

This paper is an abstract of part of an extended report on the geology and water resources of Luna County now in preparation by the Survey. It is issued to meet the urgent demand for information regarding wells and prospects for underground water in this district, especially as to the limits of the area in which water is available for irrigation. Results of pumping tests made at five representative plants are given at the end of the paper.

**WATER-SUPPLY PAPER 345-D.** Ground water for irrigation in the valley of North Fork of Canadian River near Oklahoma City, Okla., by A. T. Schwennesen. 1914. 11 pages, 1 plate.

Gives the results of a reconnaissance survey near Oklahoma City made in January, 1914, for the purpose of investigating the occurrence and quantity of available ground water. In Oklahoma the rainfall is not evenly distributed throughout the year, so that irrigation is necessary for successful farming.

**MINERAL RESOURCES OF THE UNITED STATES, CALENDAR YEAR 1912. 1913.** Part I, Metals, 1,079 pages, 3 plates, 13 text figures; Part II, Nonmetals, 1,218 pages, 8 plates, 11 text figures.

Statistics of the production, importation, and exportation of mineral substances in the United States, including accounts of the chief features of mining progress, comparisons of past and present production and conditions, and the application of the products in the useful arts. A consolidation of 63 advance chapters, each covering a single mining industry or group of allied industries.

**MINERAL RESOURCES OF THE UNITED STATES, CALENDAR YEAR 1913;** advance chapters as follows:

The production of bauxite and aluminum in 1913, by W. C. Phalen. 1914. 29 pages. Part I: 1.

The production of chromic iron ore in 1913, by J. S. Diller. 1914. 13 pages, 1 text figure. Part I: 2.

Gold, silver, copper, lead, and zinc in South Dakota and Wyoming in 1913 (mines report), by C. W. Henderson. 1914. 19 pages. Part I: 3.

The production of mica in 1913, by D. B. Sterrett. 1914. 11 pages. Part II: 1.

Fuel briquetting in 1913, by E. W. Parker. 1914. 8 pages. Part II: 2.

The production of sand-lime brick in 1913, by Jefferson Middleton. 1914. 8 pages. Part II: 3.

Sulphur, pyrite, and sulphuric acid in 1913, by W. C. Phalen. 1914. 29 pages. Part II: 4.

The production of mineral paints in 1913, by J. M. Hill. 1914. 24 pages. Part II: 5.

The production of slate in 1913, by A. T. Coons. 1914. 16 pages. Part II: 6.

Potash salts: Summary for 1913, compiled by W. C. Phalen. 1914. 23 pages. Part II: 7.

The production of fuller's earth in 1913, by Jefferson Middleton. 1914. 7 pages. Part II: 8.

The cement industry in the United States, by E. F. Burchard. 1914. 30 pages, 3 text figures. Part II: 9.

The production of feldspar in 1913, by F. J. Katz. 1914. 7 pages. Part II: 10.

The production of talc and soapstone in 1913, by J. S. Diller. 1914. 11 pages, 2 text figures. Part II: 11.

The production of silica (quartz) in 1913, by F. J. Katz. 1914. 7 pages. Part II: 13.

**GEOLOGIC FOLIO 188.** Tallula-Springfield (Ill.) folio, by E. W. Shaw and T. E. Savage. 1913. 12 folio pages of text, 4 maps, 14 text figures. Price, 25 cents. Published also in octavo form, 93 pages, maps in pocket. Price, 50 cents.

Description and maps of the Tallula and Springfield quadrangles, comprising about 458 square miles in Cass, Logan, Menard, Morgan, and Sangamon counties, Ill.

**GEOLOGIC FOLIO 189.** Barnesboro-Patton (Pa.) folio, by M. R. Campbell, F. G. Clapp, and Charles Butts. 1913. 12 folio pages of text, 6 maps, 11 text figures, 1 page of coal analyses. Price, 25 cents.

Description and maps of the Barnesboro and Patton quadrangles, comprising about 453 square miles in Blair, Cambria, Clearfield, and Indiana counties, Pa.

**GEOLOGIC FOLIO 190.** Niagara (N. Y.) folio, by E. M. Kindle and F. B. Taylor. 1913. 25 folio pages of text, 4 maps, 25 plates, 16 text figures. Contains a large-scale map of the Niagara River gorge. Price, 50 cents. Published also in octavo form, 184 pages, maps in pocket. Price, 50 cents.

Descriptions and maps of the Niagara quadrangle and a narrow strip along its west side, comprising 953 square miles in Niagara and Erie counties, N. Y., and in the Province of Ontario, Canada.

**GEOLOGIC FOLIO 191.** Raritan (N. J.) folio, by W. S. Bayley, R. D. Salisbury, and H. B. Kummel. 1914. 32 folio pages of text, 4 maps, 1 structure-section sheet, 1 columnar-section sheet, 21 text figures. Published also in octavo form, 233 pages, maps in pocket. Price, 50 cents.

Description and maps of the Raritan quadrangle, comprising about 905 square miles in Hunterdon, Middlesex, Morris, Somerset, Sussex, and Warren counties, N. J. Price, 25 cents.

**GEOLOGIC FOLIO 192.** Eastport (Me.) folio, by E. S. Bastin and H. S. Williams. 1914. 15 folio pages of text, 3 maps, 1 structure-section sheet, 23 plates, 7 text figures. Price, 25 cents.

Description and maps of the Eastport quadrangle, comprising about 250 square miles in Washington County, Maine. The quadrangle occupies the easternmost extremity of Maine, and nearly half of its area is water.

#### TOPOGRAPHIC MAPS as follows:

Alamo National Forest, N. Mex.<sup>1</sup>

Alum Mountain, N. Mex.

Alvordton, Ohio-Mich.

Baxter Bayou, La.<sup>1</sup>

Beckley, W. Va.

Bethany, Cal.

Bethel, Maine.

Big Bend, W. Va.

Brentwood, Cal.

Brockton, Mont.

Bryan, Ohio.

Bryant Pond, Maine.

Buckhorn, Ky.

Callente, Cal.

Capitola, Cal.

Cellna, Ohio.

Centralla, Ill.

Ceredo, W. Va.-Ohio.<sup>1</sup>

Cherry Ridge, Mont.

Cheyenne, Wyo.

Cholame, Cal.<sup>1</sup>

Circleville, Ohio.

Cohutta, Ga.-Tenn.

Dalingerfield, Tex.

Dannemora, N. Y.

De Queen, Ark.-Okla.

Drakesboro, Ky.

Dunmor, Ky.

Eccles, W. Va.

Era, Ohio.

Fergus Falls, Minn.

Flattop, W. Va.

Folsom, Cal.<sup>1</sup>

Gay Hill, Tex.

Green City, Mo.

Hamilton, Cal.

Hanna, Wyo.

Hollow Springs, Tenn.

Holt, Cal.

Homestead, Mont.

Indian Head, Md.<sup>1</sup>

Iuka, Miss.-Ala.-Tenn.

Jackson, Ohio.

Kentucky (State).

Kirkwood, Cal.

Leadville mining district, Colo.<sup>2</sup>

Lida, Cal.-Nev.

Lincoln, Ill.

Logan, W. Va.

Lolo, Idaho-Mont.

Lost Hills, Cal.<sup>1</sup>

Louisa, W. Va.<sup>1</sup>

Lyon Mountain, N. Y.

McIntosh Landing, Cal.

Madrid, Iowa.

Maryland (State).

Marysville Buttes and vicinity, Cal.

Mecker, Colo.

Meeteetse, Wyo.

Mercer, Pa.

Missouri (State).

Monticello, Ky.

Nanjemoy, Md.<sup>1</sup>

Navarre, Ohio.

Navasota, Tex.

Newcomerstown, Ohio.

New York (State).

Niagara Gorge, N. Y.-Canada.

Oregon Basin, Wyo.

Orland, Cal.

<sup>1</sup> Preliminary edition showing part of quadrangle.

<sup>2</sup> New edition.

Paulding, Ohio.  
 Pennsylvania, (State).  
 Phoenix, Ariz.  
 Pioneer, Ohio.  
 Raton, N. Mex.  
 Red Mesa, Colo.-N. Mex.  
 Salinas Valley, Cal., sheets Nos. 2 and 3.<sup>1</sup>  
 Sciotoville, Ohio.  
 Seale, Ala.-Ga.  
 Sidney, Ohio.  
 Slater, Iowa.  
 Slug Creek, Idaho.  
 Smithville, Mo.  
 South Carolina (State).  
 Stockton, Cal.

Stoneboro, Pa.  
 Sumner, Ill.  
 Swanton, Ohio-Mich.  
 Tintic mining district, Utah.<sup>2</sup>  
 Troublesome, Ky.  
 Van Wert, Ohio.  
 Vinita, Okla.<sup>2</sup>  
 Walcott, Wyo.  
 Wauseon, Ohio-Mich.  
 West Virginia (State).  
 Wicomico, Md.-Va.<sup>2</sup>  
 Willamette, Oreg., sheets Nos. 5 and 6.<sup>1</sup>  
 Winkelman, Ariz.  
 Woodstock, Vt.  
 Woodward Island, Cal.

## GEOLOGIC BRANCH.

## ADMINISTRATION.

The geologic branch embraces four divisions—(1) geology, David White, chief geologist in charge; (2) Alaskan mineral resources, A. H. Brooks in charge; (3) mineral resources, E. W. Parker in charge; and (4) chemical and physical researches, G. F. Becker in charge.

The scope of the work of these divisions is well established, and although each is largely autonomous, they cooperate effectively in their several lines of work. Many of the statistical reports of the division of mineral resources are prepared by geologists in the division of geology, who are specialists in the geology of the several minerals considered and whose field investigations give opportunities for close observation of the various mineral industries. During the field season members of the land-classification board are enrolled in field parties of the geologic branch engaged in the classification of the public lands.

The chief geologist plans the geologic investigations to be carried on by the Survey in the United States, and has general supervision of the field work. He gives special attention to cooperation in geology with the State surveys and is the executive officer of the branch. These duties leave him but little opportunity for systematic investigations, either in the field or in the office, the greater part of his time for field work being occupied in field inspection and conferences and the supervision of the work of the section of eastern fuels.

## PUBLICATIONS.

The publications of the fiscal year 1914 prepared in the geologic branch consisted of 24 professional papers, bulletins, etc., as well as 51 chapters of reports later published as annual volumes and 5 geo-

<sup>1</sup> Preliminary photolithograph.

<sup>2</sup> Revised and reengraved.

<sup>2</sup> New edition.

logic folios. Titles and brief notices of these publications are given on pages 13-31.

Besides these publications 48 papers were, with the permission of the Director, published in scientific journals and in the transactions of scientific societies. In view of the scientific importance of many of these shorter papers, some of which represent the by-product of investigations that are primarily economic, provision was made at the close of the year 1913 for the publication of such of these scientific papers as are complete in form, are of general interest, and do not require elaborate illustration, in a set of short professional papers to be known as "Shorter contributions to general geology." The expectation that the publication of these papers would greatly stimulate the scientific work of the Survey by encouraging broader and more thorough observation and deduction on the part of the geologist is being realized. The papers submitted and published in Professional Papers 85 and 90 have been of high merit and varied scope.

The areas in the United States covered by geologic maps published by the Survey and the general nature of the work are indicated on Plate I. It should be borne in mind that a number of reports and maps prepared by geologists of this Survey have been transmitted for publication by cooperating State surveys. The work in Alaska is given in the section on the division of Alaskan mineral resources.

#### DIVISION OF GEOLOGY.

##### ORGANIZATION.

The scientific force at the beginning of the year consisted of 62 geologists, 36 associate geologists, 27 assistant geologists, and 15 junior geologists. During the year 5 members of the scientific staff resigned to take places elsewhere at higher salaries and 11 members were appointed. The total number of geologists of various grades on the staff at the end of the year was 146. Of this number 83 were employed continuously, 23 were carried on the per diem roll, giving only part of their time to the Survey work, and 40 were not employed during the year. In addition to this force, 16 geologic aids were employed as field assistants for a part of the year.

The division of geology is organized in nine sections, as follows:

1. Section of eastern areal geology (east of the one hundredth meridian).
2. Section of western areal geology (west of the one hundredth meridian). Subsection, investigations in petrology.
3. Section of Coastal Plain investigations.
4. Section of glacial geology.
5. Section of paleontology and stratigraphy.







6. Section of metalliferous deposits.
7. Section of nonmetalliferous deposits.
8. Section of eastern mineral fuels (east of the one hundredth meridian).
9. Section of western mineral fuels (west of the one hundredth meridian).

**ALLOTMENTS.**

The total funds from the appropriations for the year 1913-14 available for geologic work of the Survey in the United States were:

Geologic surveys .....	\$300, 000
Statutory salaries.....	13, 700
Search for potash deposits (part of the appropriation for chemistry and physics).....	17, 000
	<hr/> 330, 700

The allotments of the appropriations were as follows:

Section of eastern areal geology.....	\$23, 320
Section of western areal geology.....	34, 660
Section of Coastal Plain investigations.....	13, 050
Section of glacial geology.....	6, 930
Section of paleontology and stratigraphy.....	20, 580
Section of metalliferous deposits.....	41, 760
Section of nonmetalliferous deposits (including potash) ..	31, 700
Section of eastern fuels.....	19, 800
Section of western fuels.....	34, 000
Débris investigation and inspection.....	2, 900
Geologic map editing.....	7, 020
Supervision, administration, salaries of clerical, techni- cal, and skilled-labor forces, instruments, supplies, and contingent fund.....	72, 980
	<hr/> 308, 700
Land-classification board .....	22, 000

Of the amounts allotted to the geologic branch, \$249,000 was expended directly for geologic work, including the search for potash. Of this amount \$94,000, or 37.8 per cent, was expended east of the one hundredth meridian and \$155,000 west of it. The allotment for supervision, etc., was divided in the same proportion between the eastern and the western work. As the work of the land-classification board relates only to the Western States the total amount expended on account of work in the region west of the one hundredth meridian, nearly all of which was expended in the public-land States, approximates 67 per cent of the total appropriation.

## COOPERATION WITH FEDERAL BUREAUS AND STATE SURVEYS.

The cooperative funds expended during the fiscal years 1913-14 were as follows:

General Land Office, for coal-land classification-----	\$35,000.00
General Land Office, for surveys at Caddo Lake, La.-Tex..	286.90
Indian Office, classification of land in Indian reservations, Montana, Washington, Oklahoma, California, and Idaho-----	13,047.28
Department of Justice-----	1,307.83
Bureau of Mines-----	261.21
Cooperation with States and official organizations-----	13,066.65

The money allotted by the General Land Office (\$35,000) was expended west of the one hundredth meridian, being assigned to the section of western fuels for use in the classification of public coal and oil lands.

Since last year agreements for cooperation in geologic investigations have been entered into by the State geological surveys of Iowa, Wisconsin, Michigan, and Kentucky. Geologic investigations have been carried on under cooperative agreement in 14 States—Illinois, Iowa, Kentucky, Maine, Maryland, Michigan, Minnesota, Missouri, Oklahoma, Oregon, Pennsylvania, Tennessee, Virginia, and Wisconsin.

Cooperation is effective with the Bureau of Mines in the metallographic study of ores and in the investigation of the invasion of California oil wells by salt water. The Survey has also engaged with the Bureau of Standards, the Bureau of Mines, and the Office of Public Roads in a thorough and systematic investigation of the building stones of the United States. The survey also cooperates with the Smithsonian Institution and the Isthmian Canal Commission, and in several lines of research has informal cooperation with the Carnegie Geophysical Laboratory and the marine biological station at Tortugas.

## GENERAL FEATURES OF THE WORK.

The primary function of the division of geology is to prepare a geologic map of the United States, to classify public lands, to make investigative and quantitative surveys of mineral deposits and to make all geologic, paleontologic, and petrologic researches necessary to this work. The scientific investigations of geologic problems are of kinds directly contributive to economic geology as well as to knowledge of geologic principles and phenomena. Thus the observations regarding temperatures in deep bore holes and mines will incidentally put to test the hypothesis maintained by some geologists that oil and gas bearing geologic formations have higher temperatures and offer steeper temperature gradients than formations not contain-

ing these hydrocarbons. The study of the sedimentation of the lower Mississippi River, and of the Delta in particular, bears not only on the problems of detrital transportation and filling, but also on the abatement of flood disasters, on the formation of obstructions to navigation in the Delta, and, through observations of the chemical changes in the waters and sediments, on the formation of disseminated ores from solutions in the mud and water. The analysis of crinoid stems or other invertebrate shells and tests representing moluscan types now living in different parts of the oceans promises to contribute important information as to the conditions under which dolomites and dolomitic limestones were deposited. On the other hand, the studies of the mutual relations of water, oil, and gas in rocks of varying degree of porosity and of different compositions, and of their movements under various structural conditions, which the Survey has recently felt justified in undertaking in connection with the investigation of the enormous damage occasioned in a number of oil fields by the invasion of the oil sands by water, not only promise valuable scientific results, including a better understanding of the mutual relations and the modes of occurrence of water, oil, and gas in rocks and in structures of different kinds, but assure data which will make possible far more accurate and certain prediction as to the occurrence or absence of oil and gas in commercial quantities in rocks of different textures occurring in different structural relations. These investigations have only recently been begun in the Survey. It is hoped that they may be as successful and beneficial as the longer established researches relating to the origin and modes of occurrence of the various types of ore deposits.

All these various researches, as well as the paleontologic researches, which are indispensable to the geologic mapping of the country, yield educational by-products of the highest value.

The geologic work of the division, both in the field and in the office, is under the immediate supervision of the chiefs of the respective sections, who are directly responsible for maintaining efficiency and a high standard of work. Exceptions are made of the studies of detrital deposition in California, carried on by G. K. Gilbert under the joint auspices of the geologic and water-resources branches, and the general monographic description of the geology of the Yellowstone National Park, in progress by Arnold Hague. The work of these distinguished senior geologists of the Survey is reported directly to the chief geologist.

Services varying in extent have, during the year, been rendered by this division to the Office of Indian Affairs in the classification of Indian lands; to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands; to the commission having in

charge the purchase of lands for Appalachian forest reserves in accordance with the provision of the Weeks Act; and to the Isthmian Canal Commission with respect to the geologic structure, the stability of foundation rocks, and the resources of the Canal Zone. The Department of Justice has made frequent demands on the services of the Geological Survey in connection with the prosecution of suits concerning the public lands.

#### SCOPE OF THE WORK OF THE SECTIONS.

The work of each of the several sections of the division of geology is briefly outlined in the following synopsis:

1. The section of eastern areal geology—Arthur Keith, geologist in charge—conducts reconnaissance and detailed work in areal or general geology in regions east of the one hundredth meridian, the primary object of which is to make known, mainly through folios of the geologic atlas, the general geology of the region studied, or to prepare scientific and educational descriptions of it, rather than to examine and describe or map the area especially on account of some geologic problem or some particular economic resource. The work of this section is carried on in close cooperation with several State surveys and university departments of geology, an effort being made to coordinate the work of all participants.

During the year the operations of the section have covered projects in Alabama, Arkansas, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, and Virginia.

2. The work of the section of western areal geology (west of the one hundredth meridian)—F. L. Ransome, geologist in charge—corresponds to that of the section of eastern areal geology and is similar in scope, these sections being especially charged with the preparation of the folios of the geologic atlas of the United States. The activities of the section have concerned the States of Arizona, California, Colorado, Idaho, Kansas, New Mexico, Oregon, and South Dakota.

3. The section of Coastal Plain investigations—T. Wayland Vaughan, geologist in charge—is occupied primarily with the study of the numerous geologic formations of the Atlantic and Gulf Coastal Plain, their character, extent, general structure, correlations, conditions of deposition, and history, and especially of the underground water and other mineral resources of the region. Most of the areal work of this section during the last year has been of the reconnaissance type. Its office investigations are comprehensive and broadly scientific as well as economic. The National Museum, the Bureau

of Fisheries, the Carnegie Institution, and a number of specialists in biology or paleontology, as well as the division of underground waters of the water-resources branch, have cooperated with or contributed to the work of this section.

4. The section of glacial geology—W. C. Alden, geologist in charge—is engaged in the study of the work of the great glaciers, the glacial and interglacial deposits and the contemporary deposits of the bordering regions, and the geologic history of the continent during the Pleistocene epoch. The geologists occupied with these varied and specialized problems are charged with the classification and mapping of the Pleistocene deposits of the glaciated regions. The work of this section during the year has comprised field studies and mapping and the preparation of reports covering areas in Arkansas, Illinois, Iowa, Louisiana, Maine, Massachusetts, Minnesota, Missouri, Montana, New York, Ohio, Vermont, and Wisconsin.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist in charge—is responsible for the determination of the relative ages and equivalences of the strata in different areas and for the reference of the formations to a geologic time scale. The geologists who specialize in paleontology are engaged also in working out the sequence and character of the continental changes, the physiographic and climatic conditions of the various periods, and the history of the animal and plant life of the geologic epochs. The field study of the stratigraphic distribution of the fossil floras and faunas gives the most complete key to the correlation of the beds; hence the paleontologists can most efficiently accomplish their work by close cooperation with the areal and economic geologists.

The work of this section is practically coextensive with that of the divisions of geology and of Alaskan mineral resources and is indispensable to the geologic mapping of the areas surveyed and the satisfactory determination of the structure.

6. The section of metalliferous deposits—F. L. Ransome, geologist in charge—not only studies metalliferous deposits and mines and investigates the conditions and methods of ore deposition, but also carries on reconnaissance geologic examination of many new districts and makes complete detailed areal surveys, for folio publication, of quadrangles in which metalliferous deposits are of special importance, the folios being subject to the inspection and approval of the geologists in charge of areal geology.

The geologists of the section have been engaged on projects that will be referred to in the detailed description of the work of the division in the States of Arizona, Arkansas, California, Colorado, Idaho, Missouri, Montana, Nevada, Oklahoma, Oregon, Tennessee, Utah, Washington, and Wyoming.

7. The section of nonmetalliferous deposits—H. S. Gale, geologist in charge—is concerned with the examination of the deposits of non-metallic ores and minerals, exclusive of fuels, and with the geologic investigation and mapping of regions in which such minerals are of paramount importance. Among the mineral resources with which the section is especially concerned are clay, cement rock, limestone, salt, borax, phosphate, sand, and building stone. During the year the great part of the work of the section has been divided between the search for potash in commercial quantities in the salts of the old evaporation basins or dried-up ancient lakes of the Southwest and the classification of the phosphate-bearing lands withdrawn from entry in Idaho, Wyoming, and Montana. The field work in this section has been performed in the States of California, Idaho, Minnesota, Montana, Nevada, New Mexico, Pennsylvania, and Wyoming.

8. The section of eastern fuels—David White, geologist in charge—conducts examinations of coal, oil, and gas bearing areas in regions east of the one hundredth meridian. It not only investigates and describes the economic geology, but in some regions also works out the detailed areal geology for folio publication, the folios being subject to the inspection and approval of the geologist in charge of the section of eastern areal geology. The work of this section during the year has been confined mainly to the study of coal, oil, and gas areas in cooperation with the State surveys of Pennsylvania, Virginia, Illinois, Missouri, and Oklahoma. The noncooperative work of the section was done in Ohio, Kentucky, Kansas, Alabama, West Virginia, Maryland, Louisiana, Rhode Island, and Texas.

9. The section of western fuels—M. R. Campbell, geologist in charge—conducts examinations and surveys in the fuel-bearing areas west of the one hundredth meridian similar to those carried on by the section of eastern fuels. The greater part of the work of the western section has consisted in classifying and mapping coal or oil bearing lands of the public domain in North Dakota, South Dakota, Montana, Wyoming, Colorado, New Mexico, Utah, Washington, Oregon, Idaho, and California, but a part of the work in this section was done on the quadrangle basis for folio publication, subject to the approval of the geologist in charge of the section of western areal geology.

10. The subsection of geologic map editing—G. W. Stose, geologist in charge—though really a part of the publication branch of the Survey, is conducted as a part of the geologic branch, in which the chief of the subsection is an active geologist.

#### ASSISTANCE TO OTHER DIVISIONS.

In addition to the work done in the respective sections, a considerable number of the geologists in the sections of metalliferous and *nonmetalliferous* deposits and several geologists in the sections of



eastern and western areal geology and western fuels have prepared for publication in the annual volumes of Mineral Resources reports of the production and statements of the industrial conditions relating to a large number of mineral resources with which they are especially familiar. Parts of the salaries of some of these geologists are paid from the funds of the division of mineral resources, and the traveling and field expenses incurred by others in the collection of data are also met from the funds of that division. As a result of this cooperation between the two divisions the value of the reports which will be enumerated under the division of mineral resources has been greatly increased, while the contributing geologists have at the same time acquired a wider commercial knowledge of the particular mineral deposits and industries.

A number of economic geologists of this division serve as members of the special committees of the land-classification board. The paleontologists of the division of geology report on all fossils collected for the division of Alaskan mineral resources and are called upon to classify fossils for the National Museum and, through courtesy, occasionally for foreign governments and other scientific institutions.

A close cooperation, with constant interchange of information, exists between the geologic branch and the water-resources branch.

#### COMMITTEE ON GEOLOGIC NAMES.

There has been no change in the personnel of the committee on geologic names, a standing committee of the geologic branch consisting of T. W. Stanton (chairman), M. R. Campbell (vice chairman), W. C. Alden, G. H. Ashley, Arthur Keith, F. L. Ransome, G. W. Stose, and David White. The minutes and other records are kept by the secretary, Miss M. G. Wilmarth, who also scrutinizes the geologic nomenclature and classification used in all manuscripts submitted for publication and prepares data on them for consideration by the committee. An account of the general objects of this committee and of the reference materials compiled in its records was given in the administrative report for last year. During the year this committee has considered 196 manuscripts, comprising 24,305 pages and involving about 4,187 geologic names. This is an increase of 15 manuscripts, about 9,100 pages, and more than 1,500 names over the record for the year 1912-13.



## WORK OF THE DIVISION BY STATES AND COUNTRIES.

The work of the division of geology during the year was done in the States listed below, the Canal Zone, the Hawaiian Islands, and the West Indies:

Alabama.	Maryland.	Oklahoma.
Arizona.	Massachusetts.	Oregon.
Arkansas.	Michigan.	Pennsylvania.
California.	Minnesota.	Rhode Island.
Colorado.	Mississippi.	South Carolina.
Delaware.	Missouri.	South Dakota.
Florida.	Montana.	Tennessee.
Georgia.	Nebraska.	Texas.
Idaho.	Nevada.	Utah.
Illinois.	New Hampshire.	Vermont.
Indiana.	New Jersey.	Virginia.
Iowa.	New Mexico.	Washington.
Kansas.	New York.	West Virginia.
Kentucky.	North Carolina.	Wisconsin.
Louisiana.	North Dakota.	Wyoming.
Maine.	Ohio.	

## ALABAMA.

The mapping of the areal geology of the Montevallo, Columbiana, Bessemer, and Vandiver quadrangles, Alabama, was revised and completed by Charles Butts, and the manuscripts for the two folios covering these areas have been submitted for publication.

A proposed forest reserve in Winston and Lawrence counties was examined by Mr. Butts, and a report thereon was prepared for the Forest Reservation Commission.

Stratigraphic and paleontologic materials were gathered by E. O. Ulrich at a number of points in the Bessemer quadrangle for use in the correlation of the formations of Alabama with those of other States.

Similar investigations of the deposits of Vicksburg age in the southern part of the State, covering an estimated area of 3,500 square miles, were made by C. Wythe Cooke, who has also identified Tertiary mollusks from Alabama in connection with his correlation work.

The offshore deposits of the Alabama coast were briefly examined by E. W. Shaw with aid from the Bureau of Fisheries.

A report on "Cretaceous deposits of the eastern Gulf region" by L. W. Stephenson, recently published as Professional Paper 81, contains descriptions of the Cretaceous deposits of Alabama.

The sandstones and clays of lower Oligocene age in portions of this State are described in a paper in preparation by George C. Matson.

## ARIZONA.

Some detailed mapping, with stratigraphic and petrologic studies, was done by L. F. Noble in and near the Grand Canyon of the Colorado. Important information was procured on the unconformity at the base of the Carboniferous, the stratigraphy of the Cambrian, and the character of the crystalline pre-Cambrian rocks. A report by Mr. Noble on the geology of the Shinumo quadrangle (Bulletin 549) is in press.

An economic reconnaissance of the Grand Gulch mining district was made by J. M. Hill, whose report appears as part D of Bulletin 580, "Contributions to economic geology, 1913, Part I." The Colorado River Indian Reservation was examined in detail by E. L. Jones, jr., for the purpose of land classification for the Office of Indian Affairs.

## ARKANSAS.

The Quaternary deposits and physiography of eastern Arkansas were briefly studied by E. W. Shaw, who also made a similar study covering an area of 40 square miles in the Moon Lake region for the Department of Justice.

A study of the Recent and Pleistocene geology and physiography of southwestern Arkansas was begun by Frank Leverett and George C. Matson.

A water-supply paper, "Geology and ground waters of eastern and northeastern Arkansas," by L. W. Stephenson and A. F. Crider, with a chapter on the chemistry of the waters by R. B. Dole, is in the hands of the editor.

The geologic mapping of the Hot Springs and Caddo Gap quadrangles was inspected in the field by Arthur Keith in conference with A. H. Purdue and H. D. Miser.

Extended studies of the pre-Mississippian faunas of northern Arkansas and southern Missouri, for use in the stratigraphic descriptions of the Eureka Springs-Harrison and Yellville folios, were made by E. O. Ulrich.

Stratigraphic observations were made and fossils collected by R. D. Mesler, from the Izard, Polk Bayou, and St. Clair limestones, in the valley of White River above Batesville, and Carboniferous invertebrates were collected by P. V. Roundy in the Eureka Springs and Harrison areas.

A summary report on the coal fields of this State has been submitted by Carl D. Smith for inclusion in a general report on the coal fields of the United States, which is now in preparation.

Reported occurrences of gold ore in Yell County were investigated by G. S. Rogers, and a brief announcement of his conclusions was contributed by the Survey to the public press.

The deposits furnishing precious stones in the State have been examined by D. B. Sterrett, who has described them briefly in a chapter in Mineral Resources for 1913.

#### CALIFORNIA.

The detailed survey of the Weaverville quadrangle, California, was completed by J. S. Diller and H. G. Ferguson for folio publication.

In June the reported volcanic eruption in Lassen County was investigated by Mr. Diller, whose report was immediately communicated to the public in the form of a press bulletin.

The study of the Yosemite region in detail was prosecuted by F. C. Calkins and F. E. Matthes for the purpose of publishing a descriptive and educational bulletin prior to the Panama-Pacific Exposition in 1915.

Some detailed mapping in the Rock Creek quadrangle was done by L. F. Noble.

The Allegheny district was studied by H. G. Ferguson, who prepared a report on its rich gold lodes. Mr. Ferguson also completed for publication a brief report on the pocket gold deposits of the Klamath Mountains.

A reconnaissance survey of the chromite and asbestos deposits in Shasta County and of the talc deposits in San Bernardino and Inyo counties was made by J. S. Diller. Reports on these subjects have been issued as parts of Mineral Resources for 1913.

A geologic survey of the east slope of the Sierra Nevada overlooking Owens Valley was made by Adolph Knopf, assisted by F. H. Lahee. A reconnaissance examination of the Bodie mining district, in Mono County, was also made by Mr. Knopf, and a report on the Darwin silver-lead mining district by him has been issued as Bulletin 580-A. A report on the stratigraphy of the Inyo Range is in preparation by Edwin Kirk.

A reconnaissance of the California portion of the Colorado River Indian Reservation and of the Yuma Indian Reservation for purposes of land classification was made at the request of the Office of Indian Affairs, by E. L. Jones, jr.

The areal mapping of the Priest Valley quadrangle was carried on during the months of August to November, 1913, by R. W. Pack, assisted by W. A. English and J. D. Northrop. During December Mr. Pack made a reconnaissance examination of the Marysville region to investigate the reported occurrence of oil there, and also made a trip through the San Joaquin Valley oil fields to obtain data on recent developments. Mr. Pack has submitted land-classification data on most of the areas examined, and, with Mr. English,

has prepared for publication a report on oil and coal in the Priest Valley quadrangle. A short report on the Marysville district was submitted.

In April, 1914, Mr. Pack resumed work in the Temblor Range oil fields, collecting data for a detailed report on the structure and the occurrence of oil in the Midway and Sunset fields. During the same period G. S. Rogers studied the inflow of water which has caused considerable damage in portions of the California oil fields.

Monographs on the marine Triassic invertebrate faunas of California and neighboring States are in preparation by Prof. J. P. Smith.

Brief visits to and reviews of a number of desert saline or playa areas in the southern part of the State were made by H. S. Gale and W. B. Hicks in connection with the search for potash. The general reconnaissance of the desert basins from Owens Valley through Indian Wells Valley, Salt Wells Valley, and Panamint Valley has resulted in further observations and conclusions of an interesting character, referring particularly to the Quaternary lake history of these basins and the valuable saline deposits they may contain. A paper discussing the potash and salt in the Searles Lake basin has been submitted for publication by Mr. Gale.

The salt resources of the State and the methods of production are described by W. C. Phalen in a bulletin on the salt deposits of the United States, submitted for publication. On account of the urgent demand from those interested in the mineral wealth of the gold belt, the maps showing the economic geology of the Placerville, Sacramento, and Jackson quadrangles as originally printed in the folios for these quadrangles have, together with the descriptions of the mining geology and ore deposits, been republished under a single cover (Folio Reprint 3, 5, and 11).

#### COLORADO.

A reconnaissance in the Cretaceous and Tertiary areas east of the Front Range, Colorado, was made by F. H. Knowlton and E. W. Berry, who gave special attention to the plant-bearing formations near Trinidad, Florissant, and Denver, and at Colorado Springs, where they were joined by C. W. Gilmore and T. W. Stanton in an examination of the Dawson arkose.

The Cretaceous section south of Fort Collins, from the Dakota hogback in the foothills to a point on Cache la Poudre River near New Windsor, was studied by T. W. Stanton, who thus completed a section the upper part of which was studied in 1909.

In Moffat County areal mapping for folio and economic work was continued by E. T. Hancock in the Lay, Axial, and Monument Butte quadrangles. Mr. Hancock mapped in detail an area of 283 square

miles. Land-classification data have been submitted for the Axial and Monument Butte quadrangles and are almost completed for the Lay quadrangle. Folios and detailed economic reports have been in preparation for these quadrangles, and also a detailed economic report covering 189 square miles in the Lay quadrangle.

Detailed areal mapping and economic investigations were carried on in the Red Mesa and Soda Canyon quadrangles, in La Plata and Montezuma counties, by M. A. Pishel. The work was completed over an area of 389 square miles. Mr. Pishel has submitted classification data for 376 square miles, and has in preparation an economic report on the Red Mesa quadrangle, which will appear in the bulletin entitled "Contributions to economic geology, 1915."

In July, 1913, E. G. Woodruff began a detailed examination of the oil shales of the Uinta Basin of Colorado and Utah, attention being first directed to the area lying within the State of Colorado. In addition to determining the areal distribution of the shales and their stratigraphic and lithologic character from place to place, Mr. Woodruff made field experiments to determine the percentage of oil in the shales. After July this work was continued in Utah.

The survey of the San Juan region was continued by Whitman Cross and E. S. Larsen, jr., assisted by J. F. Hunter. The work consisted in the completion of the areal survey of the Uncompahgre quadrangle and the beginning of a detailed reconnaissance survey of an area east of the region. During the winter the geologists named have been engaged on reports and special papers dealing mainly with the geology of the San Juan region. Mr. Cross transmitted for publication a paper on "The dike rocks of the Apishapa quadrangle," and, with Mr. Larsen, another entitled "Contributions to the stratigraphy of southwestern Colorado." A paper on some of the minerals of the Uncompahgre quadrangle was prepared by Messrs. Larsen and Hunter for publication in one of the scientific journals, and Mr. Hunter practically completed his report on the pre-Cambrian rocks of the Gunnison Canyon.

The Quaternary formations in the San Juan Mountains were, during July, August, and part of September, surveyed in detail by W. W. Atwood and Kirtley Mather. They completed their work in the San Cristobal quadrangle and made considerable progress in the Uncompahgre and Montrose quadrangles. A portion of October was spent by Mr. Atwood, in association with Mr. Cross, in a reconnaissance survey of the northeastern portion of the San Juan area.

The preparation of the report on the economic geology of the Central City district, by E. S. Bastin, has required more time than was expected, because of the large number of detailed mine descriptions involved. This study is practically completed. The ores of this district have been studied by Mr. Bastin and Chase Palmer in con-

nection with a series of important researches on the precipitative action of metallic minerals upon silver in solution. Specimens of enriched ores were collected and mine waters were tested.

As a part of the metallographic studies carried on by F. B. Laney, in cooperation with the Bureau of Mines, a month was spent in the field by Mr. Laney in the collection of ores from the Leadville district. The results of these studies, which are as yet incomplete, constitute a valuable contribution to the knowledge of the origin and deposition of the Leadville ores and of the formation of similar ores in general. The oxidized zinc ores at Leadville were studied by G. F. Loughlin, whose report on them, now completed, will be included in the monograph on the Leadville district which is in preparation by J. D. Irving.

A reconnaissance of the Unaweep copper district in Mesa County was made by B. S. Butler, whose report is issued as part B of Bulletin 580. A similar examination of the Hardscrabble district in Custer County was made by J. F. Hunter, whose report has been published as Bulletin 580-C.

The principal mica deposits of the State were studied by D. B. Sterrett, who has described them in a bulletin submitted for publication.

A paper on the coal measures of Raton Mesa and other coal fields in Colorado and New Mexico, by W. T. Lee, with a report on the fossil floras of the Vermejo and Raton formations, by F. H. Knowlton, was submitted for publication. Mr. Knowlton also prepared a paper on the Cretaceous-Tertiary boundary in the Rocky Mountains, which will be published outside of the Survey.

#### DELAWARE.

A folio describing and mapping the geology of the Wilmington quadrangle, in Delaware and New Jersey, has been submitted for publication by Florence Bascom and B. L. Miller, the work having been done in connection with the Geological Survey of Maryland.

#### FLORIDA.

Investigations of the geology of the Florida Keys were continued by T. W. Vaughan, who has prepared and published a number of scientific papers on the geology of this region. Mr. Vaughan, assisted by C. Wythe Cooke, studied the stratigraphy of the upper Oligocene formations in the northern and central parts of the State. Stratigraphic and paleontologic investigations in this area of approximately 2,500 square miles have been made by Mr. Cooke, who has also identified Tertiary mollusks from the State in connection with his correlation work.



The offshore deposits along the west coast of Florida and the shores of the Gulf States were briefly examined by E. W. Shaw through the courtesy of the Bureau of Fisheries, which permitted him to take advantage of a cruise of the steamer *Fish Hawk*.

A report on the phosphate deposits of Florida, by George C. Matson, was revised and transmitted for publication.

The Pliocene Foraminifera of Florida have been described in a report by Joseph A. Cushman, and another report by him on the Miocene Foraminifera is nearing completion.

A report on the geology and ground waters of Florida, by George C. Matson and Samuel Sanford, was published as Water-Supply Paper 319. The demand for this paper is so great that the edition has already been exhausted.

#### GEORGIA.

A report on "Underground-water resources of the Coastal Plain of Georgia," prepared in cooperation between the Geological Survey of Georgia and the Federal Survey, by L. W. Stephenson and Otto Veatch, with a chapter on the chemistry of the waters by R. B. Dole, is in press as Water-Supply Paper 341.

The Upper Cretaceous and Eocene floras of South Carolina and Georgia have been described by E. W. Berry in an instructive and valuable paleontologic paper, published as Professional Paper 84.

The Cretaceous deposits of the State are discussed and mapped in a paper on "Cretaceous deposits of the eastern Gulf region," by L. W. Stephenson, published as Professional Paper 81.

#### IDAHO.

The studies of the ore deposits of Idaho, which since 1910 have been in progress by J. B. Umpleby, were continued during the present year. Some mining districts in the central part of the State were reviewed by Mr. Umpleby, who later examined in detail the ore deposits in the Hailey quadrangle. His work in Idaho is expected to result in a comprehensive summary report on the ore deposits of the State. In the meantime, areas examined by him have been separately treated in shorter papers, four of which have been printed (Bulletins 528, 530-G, 539, and 540-E), and two others, on the Mackay and Sawtooth districts, are practically completed. This work has also supplied material for five articles, three of which have appeared in scientific journals during the year. These are "Custerite, a new contact-metamorphic mineral"; "Crystallized chrysocolla from Mackay, Idaho"; and "The genesis of the Mackay copper deposits."

The geology of the Hailey quadrangle has been almost completely mapped for folio publication by L. G. Westgate, who also gave some



time to the compilation of a geologic map of Idaho, in which he was assisted by R. V. Mills.

A brief examination of the lead-silver mines and prospects of the Mineral Hill district, which adjoins the Hailey quadrangle, was made by D. F. Hewett, whose report on this district is now in preparation.

The further classifications of Northern Pacific Railroad grant lands were made by E. L. Jones, jr., assisted by R. V. Mills, the selections lying in 10 townships situated chiefly in the drainage basin of the North Fork of Coeur d'Alene River; also similar lands in 9 townships situated in the drainage basins of St. Joe River and the North Fork of the Clearwater. The total area of the listed lands probably did not exceed 50 square miles, but in the course of the examination approximately 350 square miles were necessarily mapped in a reconnaissance way.

An area of about 100 square miles along Clearwater River and Orofino Creek was examined for land classification by C. T. Lupton.

At the request of the Office of Indian Affairs an examination for classification of the Fort Hall Indian Reservation was made and completed during the season by G. R. Mansfield, who was assisted in the field by J. W. Merritt and, for a short time toward the close of the season, by C. A. Bonine and Wallace Lee. Classification data for the entire reservation have been prepared and submitted, and a general report and geologic map covering the geology and phosphate deposits is well advanced in preparation. For a large part of the area the topography as well as the geology was mapped by the geologic party to facilitate the geologic mapping.

Paleontologic studies for the classification and correlation of the Carboniferous geologic formations in the Fort Hall Indian Reservation, the Hailey quadrangle, and the vicinity of Mackay, under examination respectively by G. R. Mansfield, J. B. Umpleby, and L. G. Westgate, were carried on by G. H. Girty, and a brief study of the pre-Carboniferous rocks was made by Edwin Kirk.

#### ILLINOIS.

The geologic investigations carried on by this Survey in Illinois are conducted in cooperation with the Illinois Geological Survey under an agreement which provides that approximately equal areas are to be mapped and described by the State and Federal surveys, though to some extent both organizations work in the same areas. In the Baldwin, Chester, Renault, Kimmswick, and Crystal City quadrangles, the Paleozoic strata and the economic geology are treated by the State survey, and the Pleistocene formations and physiography are described by E. W. Shaw, of the Federal Survey.

A folio describing and mapping the Colchester and Macomb quadrangles, in which certain Pleistocene deposits had been examined by Frank Leverett, was submitted by Henry Hinds. A folio covering the Paleozoic rocks in the West Frankfort and Galatia quadrangles was submitted by G. H. Cady for the State. The Galena-Elizabeth folio, prepared by E. W. Shaw and A. C. Trowbridge, is now in process of publication.

The text of the Belleville-Breese folio, by J. A. Udden and E. W. Shaw, has received final revision by Mr. Shaw and is now in the hands of the editor. Progress has been made by Mr. Shaw in the preparation of a folio for the Carlisle and Centralia quadrangles.

The field examination of the Gillespie and Mount Olive quadrangles was begun by Wallace Lee in June.

A field conference on the late Mississippian rocks of Illinois and adjacent parts of Missouri and Kentucky was held by E. O. Ulrich, Stuart Weller, and the State geologists of Illinois and Missouri.

#### INDIANA.

A reconnaissance study of the Richmond group was made by E. O. Ulrich.

#### IOWA.

A review of the evidence of an Iowan stage of glaciation and of its relations to the deposits of other Pleistocene stages in eastern Iowa and adjoining States was begun in June by W. C. Alden. This work is being done in cooperation with the State Geological Survey, which furnished an assistant, Morris M. Leighton.

#### KANSAS.

Detailed field work in the Syracuse and Lakin quadrangles, Kansas, was done by N. H. Darton, whose text and maps, for folio publication, are practically completed, except for the acquisition of certain information as to the structure of the Dakota sandstone given in well records.

An examination of the zinc deposits in the southeastern corner of the State was made by C. E. Siebenthal, the results of which will be incorporated in a report on the ores of the region.

A folio describing and mapping the geology of the Leavenworth quadrangle was submitted by Henry Hinds and F. C. Greene, the latter being the representative of the cooperating State of Missouri in the studies of the Missouri coal field, in which the greater part of the Leavenworth quadrangle lies.

## KENTUCKY.

The coal resources of the Kentucky portion of the Pound quadrangle have been described by Charles Butts in a paper to be published in part F of Bulletin 541.

A small area near Pine Mountain, in the southeast corner of the Regina quadrangle, was mapped by Henry Hinds in the summer of 1913, in connection with the examination of the Bucu quadrangle, in the southwestern Virginia coal field.

In cooperation with the Kentucky Geological Survey the detailed study and mapping of Jefferson County was begun in June by Charles Butts, assisted by T. C. Brown. The results of the comprehensive studies thus begun are to be embodied in a general report on the geology and mineral resources of the county, to be published by the State, and in folios to be issued by this Survey.

The Ordovician rocks of central Kentucky were examined by E. O. Ulrich in association with A. M. Miller for the purpose of procuring information necessary to the interpretation of the stratigraphy of the Cincinnati quadrangle.

The Pleistocene age of the Columbus and Hickman bluffs, in western Kentucky, has been demonstrated through paleobotanic evidence by E. W. Berry, who has also submitted a report on the fossil flora of the Wilcox formation.

A paper on "Cretaceous deposits of the eastern Gulf region," by L. W. Stephenson (Professional Paper 81), contains descriptions of the Cretaceous deposits of the Coastal Plain area of the State.

## LOUISIANA.

A study of the origin and history of Caddo Lake, La., was made by the Survey, under order from the Secretary of the Interior, in cooperation with representatives of the General Land Office, and a report by Frank Leverett has been submitted. During a part of the investigations Mr. Leverett was associated with George C. Matson, who had also examined the stratigraphy and geologic structure of the region including the Caddo oil field, with special reference to the mode of occurrence of oil and natural gas. A report on this field by Mr. Matson is now ready for submission.

A study of the Pleistocene deposits, the Recent offshore deposits, and the physiography of eastern and southern Louisiana was made by E. W. Shaw, who spent several weeks in a reconnaissance study of the Mississippi Delta, extending over an area of 100 square miles. A paper on "The mud lumps at the mouths of the Mississippi," by Mr. Shaw, was published as Professional Paper 85-B.

A report on the lower Oligocene floras of Mississippi, Louisiana, and Texas, by E. W. Berry, was completed last year, and will be

published in conjunction with a report by George C. Matson on the Catahoula sandstone in Mississippi, Louisiana and Texas, which is in preparation.

#### MAINE.

A review, with field conference and inspection by Arthur Keith, of the areal and economic geology of the Portland and Casco Bay quadrangles, Maine, was completed by F. J. Katz, for folio publication, in cooperation with the Maine State Water Storage Commission. The final map covering these quadrangles has been finished by Mr. Katz and the text nearly completed.

A brief reconnaissance in the Bath and Boothbay quadrangles, covering about 50 square miles, was made by Arthur Keith. Prof. C. W. Brown has continued the preparation of the folio on the Frenchmans Bay quadrangle.

The study and description of the faunas of the Silurian formations in the Eastport quadrangle have been prosecuted by H. S. Williams.

#### MARYLAND.

A detailed reconnaissance in the Williamsport and Hagerstown quadrangles, in Maryland, West Virginia, and Pennsylvania, was carried on by G. W. Stose, in association with R. S. Bassler. The maps and descriptions of these areas have been completed as far as the field work has gone.

The manuscript of the folio on the Elkton and Wilmington quadrangles, including portions of Pennsylvania and Delaware, has been submitted by Florence Bascom and B. L. Miller. This work was done in cooperation with the Geological Survey of Maryland.

A brief investigation of the underground-water conditions at Silver Spring and vicinity was made by George C. Matson in October, 1913, and a report of his conclusions was transmitted to a committee of citizens interested in the establishment of water and sewerage systems in the town.

A cooperative report on the underground waters of Maryland, Delaware, and the District of Columbia has been taken over by the Maryland Geological Survey and will be completed and published by it.

#### MASSACHUSETTS.

The description of the Boston and Boston Bay quadrangles, Massachusetts, for the Boston folio has been advanced, and the survey of the Framingham quadrangle, also for the Boston folio, has been almost completed by Laurence La Forge, who also made a reconnaissance in the Franklin and Lowell quadrangles.

Certain portions of the areal geology of the Warwick quadrangle were reviewed by Prof. B. K. Emerson, about 50 square miles having been covered in detail.

A manuscript of the "Geology of Massachusetts and Rhode Island" was carefully revised by Prof. Emerson and transmitted for publication.

A field conference in the Framingham and Franklin quadrangles was held by Arthur Keith with Prof. Emerson and Laurence La Forge. Mr. Keith also made a brief reconnaissance in the Salem quadrangle.

The Quaternary geology of the Sheffield, Sandisfield, Pittsfield, and Becket quadrangles was described for folio publication by F. B. Taylor, who in June completed the field mapping of the Quaternary deposits of the Berlin, Greylock, Hoosick, and Bennington quadrangles.

#### MICHIGAN.

A brief reconnaissance in the Carboniferous area of Michigan, particularly of the Marshall sandstone, was made by G. H. Girty for the purpose of studying the stratigraphy and collecting the fossil fauna. The report embodying the results of these studies is in preparation in cooperation with the Geological Survey of Michigan, to which it will be submitted for publication.

The salt resources of the State and the methods of production will be described by W. C. Phalen in a bulletin on the salt deposits of the United States

#### MINNESOTA.

The field examination of the clay deposits of Minnesota was finished by F. F. Grout, and a report containing descriptions of the deposits and of the results of burning tests of the clays is in preparation.

An examination of the granite area in Benton and Sherburne counties was made by Mr. Grout for description in a report by Mr. Grout and Oliver Bowles on the building and ornamental stones of Minnesota. This report is now nearly completed.

Preliminary to the preparation of a general report on the stratigraphy and economic geology of the Cuyuna iron range a large number of logs of drill holes and samples were collected by A. W. Johnston.

The work of mapping the glacial deposits of the State, with special reference to the origin of the soils, was continued by Frank Leverett, with the assistance, at different times, on the part of the State survey, of E. R. Preston, F. W. Sardeson, C. S. Corbett, and G. R. McDowell. A report covering the northwest quarter of the State was prepared by Mr. Leverett and transmitted to the director of the

Minnesota Geological Survey for publication. A paper entitled "Earth movements in the Minnesota portion of Lake Agassiz during and since the lake's occupancy" was submitted by Mr. Leverett for publication by the Geological Society of America.

The surveys of this State as described above are carried on in cooperation with the State Geological Survey of Minnesota.

The manuscripts for the Herman-Morris and St. Paul-Minneapolis folios have been revised by Mr. Sardeson, who, in company with E. O. Ulrich, reviewed the stratigraphy of the Cambrian and Ordovician formations in the St. Paul and Minneapolis quadrangles.

#### MISSISSIPPI.

A description of the Cretaceous deposits of Mississippi is contained in a paper on "Cretaceous deposits of the eastern Gulf region," by L. W. Stephenson, published as Professional Paper 81.

A brief study of the Quaternary deposits and physiography of the State was made by E. W. Shaw.

A monograph on the lower Oligocene floras of Mississippi, Louisiana, and Texas, by E. W. Berry, was completed and will be published in conjunction with a report by George C. Matson on the Catahoula sandstone in Mississippi, Louisiana, and Texas, which is in preparation.

A professional paper on "The lower Eocene flora of southeastern North America," by E. W. Berry, an exhaustive paleobotanic study of the floras as developed in the Mississippi Embayment, was transmitted for publication.

Stratigraphic and paleontologic investigations covering an area of approximately 400 square miles were made by C. W. Cooke, who has also identified Tertiary mollusks from Mississippi and prepared lists of fossils for incorporation in a report on the Coastal Plain of Mississippi to be issued by the State Survey.

One week was devoted to a conference and review of field work in Mississippi by T. W. Vaughan, G. C. Matson, and E. W. Shaw, of the United States Geological Survey, in company with E. N. Lowe, State geologist of Mississippi, and E. A. Smith, State geologist of Alabama.

#### MISSOURI.

As a part of the cooperative geologic work in Missouri the Pleistocene area of the Missouri portions of the Crystal City, Renault, Kimmswick, and Chester quadrangles were examined and mapped by E. W. Shaw for description in folios for which the Paleozoic formations and economic geology will be described by Stuart Weller and other geologists of the Missouri Bureau of Geology and Mines.



A folio covering the Leavenworth and Smithville quadrangles, also surveyed in cooperation, was completed by Henry Hinds and F. C. Greene, and a draft of the text with maps for the Queen City and Green City quadrangles was submitted by F. C. Greene, assistant geologist of the State Survey, for examination.

The report of Messrs. Hinds and Greene on the stratigraphy of the Pennsylvanian formations in the northwestern part of the State has been prepared for submission to the State for publication.

Recent developments in the Spring City mining camp were examined by C. E. Siebenthal, who completed and submitted a report on the "Genesis of the Joplin lead and zinc ores."

The first edition of the Joplin folio of the geologic atlas having been exhausted, a reprint of this folio, in view of the urgent public demand, was ordered.

Field conferences concerning the stratigraphy and classification of the upper Paleozoic rocks of the Missouri were held by G. H. Girty, E. O. Ulrich, and David White with the State geologists of Missouri, Iowa, and Illinois, and the States of the Mississippi Valley.

The Carboniferous formations and faunas of the Rolla quadrangle and of the Joplin district were studied by G. H. Girty.

The Pleistocene deposits at several points in northern Missouri were examined by Frank Leverett in connection with the work on the Queen City, Green City, Leavenworth, and Smithville quadrangles.

#### MONTANA.

The classification of the lands in the former Flathead Indian Reservation, Mont., begun at the request of the Office of Indian Affairs in 1912, was completed in 1913, the examination and report being made by R. W. Stone. A reconnaissance trip to South Fork of Flathead River resulted in brief reports on "Coal on South Fork of Flathead River, Mont.," and on the "Felix Basin copper deposits." The former will appear in the bulletin entitled "Contributions to economic geology, 1915," and the latter was given to the daily press.

Certain lands near Anaconda were examined and classified by J. M. Hill for the Department of Justice.

A reconnaissance for land classification as to the mineral or non-mineral character of Northern Pacific Railroad grant lands lying in Tps. 6 and 7 S., R. 6 W., comprising about 2 square miles, was made by E. L. Jones, jr.

E. S. Larsen and J. T. Pardee made an examination of a small district east of Libby, in which occur veins containing silicate minerals notably rich in vanadium. The vanadiferous ægirite from this district was described by Mr. Larsen and W. F. Hunt in one of the scientific journals.



The microscopic study of the Butte copper ores, which was begun by F. B. Laney before he was detailed to other work in cooperation with the Bureau of Mines, has been advanced somewhat during the year.

After completing the examination of the lands of Fort Berthold Indian Reservation of North Dakota, C. M. Bauer, assisted by C. A. Bonine, made a detailed reconnaissance survey of a part of the Ekalaka coal field, in Chester County, Mont., embracing an area of about 650 square miles. Mr. Bauer has submitted land-classification data for the area examined and has prepared for publication an economic report which will appear in the bulletin "Contributions to economic geology, 1915." He has also submitted for publication two other short papers, one on the clays of Montana and one on the late Tertiary history of upper Missouri River.

The examination of the Tullock coal field, Rosebud County, which was begun the preceding year, was continued by G. S. Rogers, assisted by Wallace Lee, who together mapped an area 435 miles in extent. Land-classification data have been submitted for this area, and an economic report is now ready for publication.

Mr. Rogers also mapped an area of 125 square miles in the vicinity of Pine Ridge, between Bighorn and Yellowstone rivers. The land has been classified and a report thereon published in Bulletin 541-H.

An area of 65 square miles in Dawson County, 20 to 35 miles northwest of Glendive, and an area of about 110 square miles south of Maudlow were mapped by C. T. Lupton, who also made a detailed reconnaissance examination of an area 30 square miles in extent near Lombard, and another 40 square miles in extent 10 miles northwest of Musselshell. The land has been classified and a report for publication is partly prepared. Mr. Lupton and E. R. Lloyd have also submitted for publication as a bulletin a final report on the Bull Mountain coal field.

The areal mapping of the Cut Bank and Blackfoot quadrangles was completed by Eugene Stebinger, who also made a reconnaissance, for classification purposes, of an area of 1,500 square miles in the vicinity of the Sweetgrass Hills. All the land has been classified, and an economic report on the coal resources of the Blackfeet Indian Reservation and a folio on the Blackfoot and Cut Bank quadrangles are in hand.

Mr. Stebinger also prepared papers on the coal fields of Montana and on the stratigraphy of the Montana group in north-central Montana.

A paper on the stratigraphy of the Montana group, with special reference to the stratigraphic position and age of the Judith River formation, has been submitted by C. F. Bowen. The two papers

last named will appear in the professional paper entitled "Shorter contributions to general geology, 1914."

Carboniferous sections on Yellowstone River above Livingston were studied by G. H. Girty, and a field study of the paleontology and stratigraphic relations of the Jefferson limestone in southwestern Montana was made by Edwin Kirk, who also examined some points in the Phillipsburg quadrangle.

Collections of vertebrate fossils from the Two Medicine formation in the Blackfeet Indian Reservation was made by C. W. Gilmore, temporarily transferred from the National Museum to the Geological Survey. The results of Mr. Gilmore's researches will be published by the Geological Survey and the National Museum.

Field studies were made and fossils were collected in the Livingston formation west of the Crazy Mountains by F. H. Knowlton, E. W. Berry, and T. W. Stanton. Mr. Stanton examined the Pierre shale and Lance formation in the neighborhood of Glendive.

The examination of the Garrison-Drummond phosphate withdrawals, embracing an area of about 640 square miles, a part of which included lands in which some work had been done the preceding year, was concluded by J. T. Pardee, and classification plats and reports concerning these lands have been filed with the land-classification board. Phosphate withdrawals, about 50 square miles in extent, near Elliston and Helena were examined in August and September by R. W. Stone, assisted by C. A. Bonine. A joint report on the Elliston phosphate field by Messrs. Stone and Bonine has been submitted for publication as Bulletin 580-N.

The Quaternary geology of Glacier National Park was studied by W. C. Alden, in company with C. S. Corbett and a party under the direction of M. R. Campbell. This work included sounding of lakes and study of existing glaciers and of the physiography and Pleistocene deposits of the region. A paper by Mr. Alden on the glaciers of the park was published by the Department of the Interior as one of its series of pamphlets descriptive of the national parks.

#### NEBRASKA.

Studies of the early Pleistocene in the vicinity of Omaha, Nebr., were made by W. C. Alden in association with W. T. Lee.

In the Pennsylvanian formations near Missouri River correlations have been made and the continuity of the members in Missouri and Kansas has been determined and is described in a report on the stratigraphy of the Pennsylvanian in northern Missouri, by Henry Hinds and F. C. Greene, prepared in cooperation with the Missouri Survey, to which it is to be transmitted for publication.

## NEVADA.

Reconnaissance examinations of mining districts in eastern Nevada were continued by J. M. Hill, who visited 26 localities in Elko, White Pine, Lincoln, and Clark counties and the Ravenswood district, in Lander County. His report is in preparation.

A report on the National district by Waldemar Lindgren has been completed.

The Rawhide, Eagleville, Terrell, Denway, Cox Canyon, I. X. L. Canyon, Bernice, and Alpine mining districts were examined by F. C. Schrader, who also studied and prepared a report on the Rochester mining district.

The report on the geology and ore deposits of the Ely district has been completed by A. C. Spencer.

Drilling was prosecuted in Columbus Marsh, and the playa and the outline of the Quaternary lake that occupied this basin were mapped in detail. The chemical study of the samples obtained from the drillings at this locality has been continued, chiefly for the bearing they have on the general study of the salines in the desert-basin region. High potash tests obtained from some of the muds in the Columbus basin are now shown to be the result of absorbed or loosely combined potassium held by these colloidal sediments, and it is believed that this example may illustrate and help to explain the apparent disappearance of much of the potassium content of original drainage waters that must have collected and concentrated in this and other basins.

The drilling of a series of shallow wells in the Black Rock Desert as a part of potash investigation was intended to be supplemented by the sinking of at least one deep hole, but a period of unusually stormy weather for this desert region made operations impossible in the spring of 1914. This work was under the supervision of Hoyt S. Gale, with whom W. B. Hicks, R. K. Bailey, and Charles E. Watson were associated in the field work and Messrs. Hicks and Bailey in the laboratory chemical investigations.

## NEW HAMPSHIRE.

The areal survey of the Milford quadrangle, New Hampshire, was continued by Prof. B. K. Emerson for folio publication, the work relating largely to the Pleistocene deposits. A field conference in the Peterboro quadrangle was held by Arthur Keith with Prof. Emerson.

The pyrite deposits in the vicinity of Milan, in Coos County, were examined by W. C. Phalen.

## NEW JERSEY.

The areal survey of the Easton quadrangle, in New Jersey and Pennsylvania, was continued, in cooperation, by Dr. H. B. Kümmel, State geologist. A field conference was held by Arthur Keith with Dr. Kümmel in this quadrangle.

The pre-Cambrian portion of the Ramapo-Greenwood Lake folio has been revised by Prof. W. S. Bayley.

## NEW MEXICO.

At the request of the Office of Indian Affairs, about 5,000 acres of irrigable land lying under the Hogback Canal in the Navajo Indian Reservation, N. Mex., was examined for purposes of land classification, which was made by M. A. Pishel.

A detailed examination for land classification of an area of 75 square miles in the vicinity of Gallup, McKinley County, was made by C. T. Lupton.

Under instructions of the Secretary of the Interior a commission consisting of C. T. Lupton, geologist, chairman, and C. B. Barker and A. G. Jaffa, mineral inspectors of the General Land Office, examined an area of 60 square miles west and south of Gallup, for the purpose of determining the coal content of the land. A report thereon has been submitted to the Secretary of the Interior.

The detailed mapping of the Raton and Brilliant quadrangles, in the Raton coal field, was completed by W. T. Lee, assisted by K. C. Heald. A folio and an economic report on the coal resources of these two quadrangles are in preparation.

The Datil Mountain coal field, in Socorro and Valencia counties, about 730 square miles in extent, was surveyed in detailed reconnaissance by D. E. Winchester, who has classified the lands and is preparing a report. A review of the Cretaceous section in this coal field was made by Mr. Winchester and T. W. Stanton, and Mr. Stanton also made a brief study of the section of the Rio Grande on Elephant Butte.

An area of about 1,800 square miles, mainly in central New Mexico, in Rio Arriba, Sandoval, Valencia, Bernalillo, San Miguel, Socorro, Lincoln, Guadalupe, Gallina, and Otero counties, was examined in reconnaissance by N. H. Darton, in a study of the stratigraphy and conditions of sedimentation and chemical deposition in the "Red Beds" in the Southwestern States. Brief visits were also made to salt deposits near Salina, Utah, and St. Thomas, Nev. It is hoped that the study of the "Red Beds" and their great gypsum deposits may reveal a relation of the gypsum beds to the more soluble salts of desiccated saline water deposits and result in the discovery of potash-bearing salts.

A portion of the coal lands in the Zuni Indian Reservation, which were examined in 1912, has been classified and reported on by D. E. Winchester.

The deposits furnishing precious stones have been examined by D. B. Sterrett, who has described them briefly in a manuscript submitted for publication as a part of Mineral Resources for 1913.

A paper on the coal measures of Raton Mesa and other coal fields in Colorado and New Mexico, by W. T. Lee, with a report on the fossil floras of the Vermejo and Raton formations, by F. H. Knowlton, was submitted for publication. Mr. Knowlton also prepared a paper on the Cretaceous-Tertiary boundary in the Rocky Mountains.

#### NEW YORK.

The areal survey of the Hoosick quadrangle, New York, was completed by L. M. Prindle, who also continued the areal mapping of the Berlin quadrangle, including a portion of Massachusetts. A field conference was held by Arthur Keith with Mr. Prindle in the Berlin quadrangle.

For the Sheffield and Pittsfield quadrangles manuscripts descriptive of the Quaternary geology were prepared and transmitted for folio publication by F. B. Taylor, who, in June, completed the field mapping of the Quaternary deposits in the Berlin and Hoosick quadrangles, which, like those already mentioned, lie partly in this State.

A report on the geology of Long Island, by M. L. Fuller, has been issued as Professional Paper 82.

A folio by E. M. Kindle and F. B. Taylor, describing in detail the geology of the Niagara Falls quadrangle and written with special reference to the educational features of the region, was issued in August. A part of this material was prepared with the cooperation of the Geological Survey of Canada.

The Cambrian and early Ordovician formations of the Ogdensburg quadrangle were examined by E. O. Ulrich and H. P. Cushing, and the study of the late Ordovician formations of western and central New York with special reference to their bearing on the Ordovician-Silurian boundary was made by Mr. Ulrich in association with C. A. Hartnagel, of the New York State Survey.

The salt resources of the State and the methods of production are described by W. C. Phalen in a bulletin on the salt deposits of the United States.

The pyrite deposits in St. Lawrence County were examined by Mr. Phalen for discussion in a chapter in Mineral Resources for 1913.

## NORTH CAROLINA.

The areal and economic survey of the Lincolnton quadrangle was completed by D. B. Sterrett, who also made a reconnaissance of about 100 square miles adjoining this quadrangle.

The survey of the portions of the Kings Mountain and Gaffney quadrangles lying in North Carolina was reviewed by Mr. Sterrett in conference with Arthur Keith.

A description of the principal mica deposits of the State, prepared by Mr. Sterrett, was submitted for publication as a bulletin. The deposits furnishing precious stones in the State have also been examined by Mr. Sterrett, who has treated them briefly in a chapter in *Mineral Resources* for 1913.

A monograph on the Cretaceous Mollusca of North Carolina, by L. W. Stephenson, to be published as a cooperative report by the North Carolina Geological and Economic Survey, is nearly completed. A report entitled "Cretaceous deposits of the eastern Gulf region and Species of *Exogyra* from the eastern Gulf region and the Carolinas," by L. W. Stephenson, was published as Professional Paper 81.

The Pliocene Foraminifera of the State are described in a report by Joseph A. Cushman, and a paper by him on the Foraminifera of Miocene age is nearing completion.

## NORTH DAKOTA.

An area of approximately 216 square miles in the Fort Berthold Indian Reservation, N. Dak., was examined for land classification by C. M. Bauer, assisted by C. A. Bonine, and they have classified the lands and prepared a report on the area for publication.

Work on the Cannonball River lignite field was continued during the year by E. R. Lloyd, who made a detailed reconnaissance of an area about 1,200 square miles in extent in the valleys of Cannonball and Heart rivers. Much time was given to the Cannonball marine member of the Lance formation, concerning which a joint report by Mr. Lloyd and C. J. Hares has been submitted for publication. The land was classified, and a report on the coals by Mr. Lloyd has been published as Bulletin 541-G.

A field conference on the stratigraphy and relations of the Cannonball marine member in Morton County was held by E. R. Lloyd, E. W. Berry, F. H. Knowlton, and T. W. Stanton; and Mr. Stanton has discussed the formation and its invertebrate fauna in a paper on "The boundary between Cretaceous and Tertiary in North America."

A reconnaissance survey of an area of about 100 square miles in the vicinity of Devils Lake was made by Eugene Stebinger, who classified the lands.



## OHIO.

The Paleozoic formations in the Hamilton and Mason quadrangles, Ohio, were mapped in detail by R. S. Bassler for folio publication, about 220 square miles having been covered. The manuscript for the folio for these quadrangles, by Dr. Bassler, in association with N. M. Fenneman, who will describe the Pleistocene formations and the economic geology, is well advanced.

A part of Ashland County, reported to contain tilted shore lines, was examined by Frank Leverett.

The preparation of a folio text for the Steubenville and Cadiz quadrangles was resumed by D. D. Condit, who during the greater part of the year was occupied with the classification of withdrawn phosphate lands in Wyoming.

## OKLAHOMA.

Field work in the Hominy quadrangle, Oklahoma, has been completed by Robert H. Wood, assisted by C. C. Turnbull, in cooperation with the Oklahoma Geological Survey. Field conferences in this work were held between Mr. Wood and Arthur Keith and with C. W. Shannon, State geologist. A folio and an economic report on the Hominy quadrangle, by Mr. Wood, are nearly completed.

A reconnaissance in the western half of the Osage Indian Reservation was made by Mr. Wood.

The economic report on the Vinita and Nowata quadrangles, prepared by D. W. Ohern in cooperation with the State, has been submitted.

A reconnaissance covering about 100 square miles in the Pawhuska quadrangle was made by Carl D. Smith, whose reports on the Pawhuska quadrangle have been well advanced. The report on the Claremore quadrangle is prepared in cooperation with the Oklahoma Geological Survey.

The preparation of the manuscript for the folio on the Sallisaw and Sanbois quadrangles has also been well advanced by Mr. Smith.

A report on the coal fields of Oklahoma, designed for inclusion in a general report on the coal fields of the United States, has been begun by Mr. Smith.

The preparation of the folio for the McAlester quadrangle has been resumed by J. A. Taff under a contract. The long suspension of this work was caused by the resignation of Mr. Taff, several years ago, from the Survey.

The area along Red River in Cotton, Jefferson, and Carter counties, lying east of that described by M. J. Munn in Bulletin 547 and extending eastward to the Chicago, Rock Island & Pacific Railroad, was examined and mapped in detailed structural reconnaissance by



Carroll H. Wegemann, assisted by A. E. Fath and R. W. Howell, and a report describing the structure, with special reference to oil and gas possibilities, was prepared. In connection with this field work preliminary examination of the Healdton and Loco oil fields were made, and brief reports on the structure of these pools are nearly completed. The work by Mr. Wegemann's party was conducted in cooperation with the State Geological Survey, which defrayed a part of the expense.

Further examinations of the geology in the Wyandotte quadrangle, in the northeast corner of the State, were made by C. E. Siebenthal, who was joined for a time by G. H. Girty for the purpose of obtaining paleontologic material adequate for the correlation and classification of the formations. Special attention was given by Mr. Siebenthal to the recent developments in the Miami camp, which it is expected will be the subject of an economic report.

Extensive collections of fossil invertebrates were obtained by P. V. Roundy for use in connection with the stratigraphic study of the Carboniferous formations in the Pryor and Muskogee quadrangles.

#### OREGON.

Mapping of the geology of the Sumpter quadrangle, Oregon, for folio publication, was begun in 1908 by J. T. Pardee. After November 1, 1909, no further work was done in this area until the fall of 1913, when, under a cooperative agreement between the Federal Survey and the Oregon Bureau of Mines and Geology, 50 square miles was mapped by F. J. Katz. Under this agreement, which includes the preparation of an economic bulletin to be published by the Oregon Bureau and the publication of a geologic folio by the Federal Survey, field work was resumed June 1, 1914, by J. T. Pardee and D. F. Hewett, and is now being carried to completion.

A reconnaissance of the Klamath Indian Reservation for the purpose of mineral-land classification was made in the fall of 1913 by H. G. Ferguson, whose report has been submitted.

A report on the mineral resources of southwestern Oregon, by J. S. Diller, was published as Bulletin 546.

A detailed examination of 10 square miles in the Eden Ridge coal field, Coos County, was made by C. E. Leshner, for the purpose of classifying the land as coal or noncoal. Float and sink tests of 26 samples of the coal and ash determinations of 80 samples were made. The land examined has been classified and a report published.

#### PENNSYLVANIA.

The folios and economic bulletins covering the Punxsutawney, Houtzdale, and Curwensville quadrangles, Pennsylvania, have been brought nearly to completion by G. H. Ashley, under whose direc-

tion additional field observations of the coals and fire clays were made during July and August by J. H. Hance, who sampled the clays for tests in the Pittsburgh laboratories of the Bureau of Standards. In connection with this work Mr. Hance sampled the clay mines at a number of points in Blair and Cambria counties.

The Newcastle quadrangle, which was examined some years ago by F. W. De Wolf, prior to his appointment as State geologist of Illinois, will be described in both a folio and an economic bulletin by Mr. De Wolf, who, in order to bring the economic developments to date, made in June additional examinations in the field, where he was for a few days assisted by A. E. Fath and R. V. Mills. The above-mentioned work by Mr. Ashley and Mr. De Wolf is done in co-operation with the Topographic and Geologic Survey Commission of Pennsylvania.

The final revision of the areal-geology map of the Gettysburg quadrangle has been made by George W. Stose, who has partly prepared the descriptive text for the folio covering the Fairfield and Gettysburg quadrangles.

A special examination and brief report were made by Mr. Stose on the water resources of a small area around Monterey.

The manuscript for the folio on the Bellefonte quadrangle has been revised and transmitted by Prof. E. S. Moore for publication.

The survey of the Huntingdon quadrangle was completed for folio publication by Charles Butts, who has reviewed his former work in the Hollidaysburg quadrangle. The maps and descriptions for a Hollidaysburg-Huntingdon folio are three-fourths completed.

A detailed reconnaissance covering about 100 square miles in the Elkton quadrangle in review of former work was made by Florence Bascom, who has transmitted the manuscript maps and text for the Elkton-Wilmington folio.

The detailed mapping of the crystalline rocks of the Reading area has been completed by Eleanora F. Bliss, and the sedimentary formations in the same quadrangle have been mapped in detail by E. T. Wherry.

The mapping of the Allentown quadrangle for publication in the Allentown-Easton folio was continued and nearly completed by Prof. B. L. Miller.

The Somerset quadrangle was examined and mapped in detail by G. C. Richardson, who has nearly completed the text for the folio covering this quadrangle.

#### RHODE ISLAND.

Field examinations in the Narragansett Basin, R. I., were made and a full report on the coals and their adaptabilities has been submitted by G. H. Ashley. A preliminary summary of Mr. Ashley's results was published in Bulletin 541-F.

## SOUTH CAROLINA.

A reconnaissance in the Gaffney and Kings Mountain quadrangles, South Carolina, was made by D. B. Sterrett, in company with Arthur Keith, in review of previous work in those areas. The geologic folio in preparation by Mr. Sterrett for these quadrangles is well advanced.

A brief examination of the phosphate developments in the State was made early in the summer by G. S. Rogers, whose report is in press as Bulletin 580-J.

A study of the principal mica deposits of the State was made by D. B. Sterrett and the report submitted.

The deposits furnishing precious stones in the State have been examined and described by Mr. Sterrett.

A report on "The Upper Cretaceous and Eocene floras of South Carolina and Georgia," by E. W. Berry, was published as Professional Paper 84, and papers on the "Cretaceous deposits of the eastern Gulf region, and Species of *Exogyra* from the eastern Gulf region and the Carolinas," by L. W. Stephenson, was issued as Professional Paper 81.

A report on "A deep well at Charleston, S. C.," by L. W. Stephenson, including a report on the Foraminifera, by Joseph A. Cushman, and a discussion of the chemistry of the water, by Chase Palmer, was completed.

A monograph on the Pliocene Foraminifera was transmitted by Joseph A. Cushman, and a report on the Foraminifera of the Miocene, by the same author, is now nearly written.

## SOUTH DAKOTA.

An area of about 700 square miles of pre-Cambrian rocks within the Deadwood, Rapid, Hermona, and Harney Peak quadrangles, in the Black Hills, S. Dak., was mapped for folio publication by Sidney Paige and two assistants. During the winter Mr. Paige continued the preparation of folios covering these quadrangles. A short field season in 1914 will complete this work. N. H. Darton, who mapped the younger formations in these quadrangles, spent some time in preparing the text for the Deadwood-Rapid folio and nearly completed the text for the Newell folio. For the latter, however, a small amount of field work is still necessary to determine the Lance and Fox Hills boundary.

Field work on the lignite area of South Dakota was completed in 1912. The reports of all the geologists who have been engaged in this work were consolidated into a joint report under the caption "The lignite field of northwestern South Dakota," by D. E. Winchester, C. J. Hares, E. R. Lloyd, and E. M. Parks, which will be published as a bulletin.

## TENNESSEE.

A report by Charles Butts on the geology and coal resources of the Crossville quadrangle, Tennessee, which was surveyed in cooperation with the State, has been submitted and will be published by the State Geological Survey.

The section of the report on the Ducktown district for which Prof. W. H. Emmons is responsible has been submitted and the manuscript is now in the hands of F. B. Laney, the author of another section of the report.

The deposits of iron ore in eastern Tennessee will be described in detail by E. F. Burchard in a bulletin now nearly completed. The preparation of Mr. Burchard's manuscript has been seriously interrupted by his work in Alaska and other areas. The stratigraphy of the formations associated with the iron-ore deposits was briefly studied in the field by E. O. Ulrich.

Under cooperative auspices the areal geology and mineral resources of the Waynesboro quadrangle were surveyed in detail by H. D. Miser, assisted on the part of the State by N. F. Drake, Bruce Wade, and O. P. Jenkins. An additional area, embracing 100 square miles, west of this quadrangle was examined in reconnaissance by Mr. Miser, who has begun the compilation of notes and maps for the folio on the Waynesboro quadrangle. A preliminary report, "The resources of the Waynesboro quadrangle," by Mr. Drake, with contributions by Mr. Miser, has been submitted for publication by the State Geological Survey.

The bauxite deposits near Keensburg, Carter County, were studied by W. C. Phalen and are discussed in the appropriate chapter in Mineral Resources for 1913.

An examination of the Chickasaw Bluffs, in the western part of the State, was made by E. W. Berry, who by means of paleobotanic evidence has found beds of Claiborne age at that point. Fossil plants of Wilcox age from Tennessee are described in a report submitted by Mr. Berry.

The Cretaceous formations of the State are described by L. W. Stephenson in a report published as Professional Paper 81.

Unpublished geologic map data were furnished to the State Survey for use in the publication of a new geologic map of the State.

## TEXAS.

Field investigations in southwestern Texas, particularly in the section in the Nueces Valley of Zavalla, Dimmit, La Salle, and McMullen counties, were made by Alexander Deussen, and some reconnaissance work done in Duval, Jim Wells, Brooks, and Willacy counties, an area of 6,000 square miles being covered by the field

work. Numerous samples from deep wells in the Texas Coastal Plain were studied and a complete set of drill samples and accurate data concerning a well at Fowlerton were obtained, as also were samples from well drillings at Marion, Maxwell, Crystal City, and other points. Logs of wells bored in the Paleozoic formations of the State were collected and geologically interpreted by J. A. Udden, geologist of the State Bureau of Economic Geology and Technology.

A brief examination of the offshore deposits was made by E. W. Shaw during a cruise of the Bureau of Fisheries steamer *Fish Hawk*.

Fossil plants were collected from the Catahoula and Yegua formations of eastern Texas by E. W. Berry in the course of his paleobotanic studies.

A report on the "Geology and underground water resources of Texas east of Brazos River," by Alexander Deussen, will soon be published as Water-Supply Paper 335.

A report on the underground water supply of La Salle and McMullen counties, with notes on the oil, gas, and lignite occurrences in McMullen County and a detailed description of the Tertiary formations in the Nueces drainage basin of southwestern Texas, by Alexander Deussen, including a chapter on the ground waters of Dimmit, La Salle, and McMullen counties, by R. B. Dole, has been transmitted for publication.

Portions of the Brackett quadrangle were examined by T. Wayland Vaughan, whose folio covering this quadrangle is nearly completed.

The structure of the Caddo oil field, which embraces a small area in eastern Texas, has been described and mapped by G. C. Matson in a report nearly ready for submission.

The geologic section in the Franklin Mountains near El Paso was studied by Edwin Kirk.

The cooperation of this Survey has been extended to the State Bureau of Economic Geology and Technology, under the direction of William B. Phillips, in the preparation of the geologic map of the State, now in progress by J. A. Udden.

The principal mica deposits of the State and the deposits furnishing precious stones have been examined by D. B. Sterrett.

A report on the lower Oligocene floras of Mississippi, Louisiana, and Texas, by E. W. Berry, was completed last year and will probably be published in conjunction with a report by George C. Matson on the Catahoula sandstone in Mississippi, Louisiana, and Texas now in preparation.

A report, with maps, on the "Geology and underground waters of the central Coastal Plain region of Texas," by Alexander Deussen, is nearing completion.

## UTAH.

The detailed report on the geology and ore deposits of the Tintic district, whose completion has been delayed through the resignation from continuous service of its senior author, Waldemar Lindgren, is practically finished, and the part of the report by C. F. Loughlin has been brought up to date. A paper on the oxidized zinc ores of the district was published by Mr. Loughlin in the journal *Economic Geology*. He also prepared a paper on a reconnaissance in the Canyon Range, west-central Utah, to be published by the Survey in "Shorter contributions to general geology, 1914" (Professional Paper 90). During the field season Mr. Loughlin completed reconnaissance surveys of the Blue Bells, West Tintic, Leamington, Saline Creek, Provo, American Fork, Farmington, Sierra Madre, Willard, Argenta, and Morgan districts. Reports on these districts will form a part of a general work on the ore deposits of Utah which is being prepared by B. S. Butler, in collaboration with Mr. Loughlin.

A reconnaissance of the uranium, vanadium, and copper deposits of the eastern part of the State was made by Mr. Butler and F. L. Hess.

In the Sunnyside and Wellington quadrangles an area of about 35 square miles was resurveyed in detail by F. R. Clark, who also examined two other small areas, one north of Thompson, the other south of Wales, for purposes of land classification. A folio and economic reports by Mr. Clark on these quadrangles are in preparation.

The investigation of the oil-bearing shales of the Uinta Basin, in western Colorado and northeastern Utah, was begun by E. G. Woodruff in August. The study of the stratigraphy and the mapping of these shales was supplemented by practical distillation tests in the field of the shales in the vicinity of Dragon, Watson, and White River in Utah, the results of which have been described by Mr. Woodruff and David T. Day in Bulletin 581-A. Office work was continued in the preparation of a more detailed report on the shales and a report on the geology of the Vernal quadrangle. In February Mr. Woodruff resigned from the service to accept a position in private work. The investigation of the oil shales of this region and of their commercial possibilities was continued by D. E. Winchester in June.

The pre-Carboniferous sections in northern Utah, chiefly in the Randolph quadrangle, were studied by Edwin Kirk.

The salt resources of the State and the methods of production will be described by W. C. Phalen in a report now in preparation.

## VERMONT.

Detailed geologic mapping of the Bennington quadrangle, Vermont, was continued and practically completed by L. M. Prindle,



with whom a field conference was held by Arthur Keith. Mr. Prindle has continued the preparation of the Hoosick-Bennington folio.

A reconnaissance covering about 165 square miles in the Londonderry, Wilmington, and Townsend quadrangles and a detailed reconnaissance of 5 square miles in the Wilmington quadrangle were made by T. Nelson Dale, who has submitted the results of this work for publication.

Arthur Keith continued his special investigation of the stratigraphy and faulted structure of the Taconic Mountains in the Brandon and Castleton quadrangles and has made a detailed examination of the Cambrian and pre-Cambrian rocks in the northern part of the Rutland quadrangle. A paper embodying some of the results of Mr. Keith's studies in the Brandon quadrangle was presented at the December meeting of the Geological Society of America.

#### VIRGINIA.

In continuance of the detailed survey of the southwestern Virginia coal field in cooperation with the Virginia Geological Survey the Virginia portion of the Regina quadrangle and the greater part of the Bucu quadrangle were mapped by Henry Hinds, assisted on the part of the State, in 1913, by T. K. Harnesberger, and in June, 1914, by C. M. Bauer.

A report on the geology and coal resources of the Pound quadrangle, geologically mapped in 1912 by Charles Butts, appears in Bulletin 541-F.

The mapping of small areas in the Abingdon quadrangle was revised by G. W. Stose, who also studied the gypsum mines in this quadrangle. A brief study of certain stratigraphic points in the quadrangle was made by E. O. Ulrich.

An examination of the proposed national forest in the Lexington and Natural Bridge quadrangles, including a geologic reconnaissance, was made by Mr. Stose, who also studied the gypsum mines in this quadrangle and reported on the question of acquiring an extension of the Natural Bridge National Forest under the Weeks law. A brief study of certain stratigraphic points in the quadrangles was made by E. O. Ulrich.

The rutile deposits of Virginia are given prominence in a report by T. L. Watson on "The rutile deposits of the eastern United States," which will be published as Bulletin 580-O.

A quantitative and qualitative examination of the semianthrinite coals in the Pocono formation (basal Mississippian) of the State was begun in the spring and nearly completed by R. W. Howell, the work being done in cooperation with the Virginia Geological Survey. The purpose of the investigation is to acquire information as to the



amount, distribution, accessibility, and characters of this reserve of semianthracite coal in Virginia.

A study of the principal mica deposits of the State was made by D. B. Sterrett.

#### WASHINGTON.

A rapid reconnaissance for the classification of coal land withdrawn from entry, embracing 700 square miles in Skagit and Whatcom counties, Wash., was made by C. E. Lesher, who classified the larger part of the area.

A reconnaissance for oil and gas was made in Chehalis, Jefferson, and Clallam counties, northwestern Washington, by C. T. Lupton, who examined an area of 1,300 square miles in detailed reconnaissance and 350 square miles in rapid reconnaissance and submitted his report.

The field examination of lands in the diminished Colville Reservation by J. T. Pardee, begun in 1912, was carried to completion in 1913, and maps and reports for the classification of these lands have been submitted.

Bulletin 550, on the ore deposits of northeastern Washington, by Howland Bancroft, with a report on the Republic district by Walde-mar Lindgren and Mr. Bancroft, was issued during the fiscal year.

#### WEST VIRGINIA.

Portions of the Steubenville, Frostburg, Flintstone, and Williamsport quadrangles, in West Virginia, have been under examination for description with the object of folio publication, the folio covering the Steubenville quadrangle being in preparation by D. D. Condit, and folios for the remaining quadrangles, which were surveyed in cooperation with the Maryland Geological Survey, being prepared by G. W. Stose, together with R. S. Bassler, G. K. Swartz, and other members of the Maryland Geological Survey.

The coals of the Pocono formation in Virginia and West Virginia were, in June, examined by R. W. Howell for description in a brief report on the semianthracite coal resources of the Pocono formation in the Virginian region.

#### WISCONSIN.

A report on the Quaternary geology of southeastern Wisconsin, with a chapter on the older rock formations, received final revision from W. C. Alden and was transmitted for publication.

At the request of the Wisconsin Geological and Natural History Survey the Federal Survey, through E. O. Ulrich, made a somewhat brief field study, in company with W. O. Hotchkiss and Samuel

Weidman, of the pre-Ordovician rocks of the western part of the State. Assistance has been extended by the State in the paleontologic determinations of invertebrate fossils from Wisconsin in the collections of the Federal Survey.

## WYOMING.

The examination for more definite delimitation of the extensive phosphate withdrawals in Wyoming was continued and nearly completed during the season by parties under the direction of Eliot Blackwelder and D. Dale Condit, with Hyrum Schneider as assistant during the first half of the field season. Mr. Blackwelder's work was chiefly on the north slope of the Owl Creek Mountains, and Mr. Condit's examinations covered the south slope of the Owl Creek Mountains, the western extension of the phosphate outcrop along the south slope of the Absaroka Mountains and the northeast slope of the Wind River Mountains. During the last half of the season Mr. Condit was associated in the field work with A. R. Schultz. The total area covered by the two parties in reconnaissance and detailed work was about 1,000 square miles, of which about 540 square miles was mapped in detail. The classification data submitted to the land-classification board cover parts of 48 townships in the Owl Creek and Absaroka mountains and 55 townships on the northeast slope of the Wind River Mountains.

A field examination of the gold placers on the Wind River or Shoshone Indian Reservation along nearly 200 miles of Wind and Bighorn rivers and their tributaries was made by F. C. Schrader in September and October. Classification data were submitted and a report was prepared for the bulletin entitled "Contributions to economic geology, 1913, Part I" (Bulletin 580).

The Moorcroft oil field, embracing a small area near Moorcroft, Crook County, was examined in July by V. H. Barnett, who classified the land and prepared a report on the oil field for "Contributions to economic geology, 1913, Part II" (Bulletin 581).

In the later part of the season the Glenrock coal field, approximately 1,300 square miles in area, in Converse and Natrona counties, was studied in detail by Mr. Barnett, who submitted data for the classification of the land and prepared reports on the coal field and on the prospects for oil in the Big Muddy dome of the Glenrock field.

Detailed folio work in the Hanna and Walcott quadrangles, in Carbon County, was carried on by C. F. Bowen, assisted by F. A. Herald. An area of about 300 square miles was mapped, leaving one-half of the Hanna quadrangle to be covered. Land-classification data have been partly prepared, and a geologic folio and an economic

report on the quadrangles are in preparation and will be finished as soon as the field work is completed.

An area embracing about 100 square miles in the Shirley Basin, Carbon and Natrona counties, was examined in rapid reconnaissance for land classification by Mr. Bowen. Part of this land has been classified, but no report for publication is contemplated.

An investigation of the prospects for oil and gas in the structural domes occurring between Casper and Lander, Natrona and Fremont counties, in central Wyoming, was undertaken by C. J. Hares, assisted by Max W. Ball and Stuart St. Clair. A total of 2,330 square miles was examined, of which 1,180 square miles was covered in detail, 970 in detailed reconnaissance, and 180 in rapid reconnaissance. The work is to be continued for another season, after which a final report covering the entire area is to be prepared.

The detailed areal survey of the Ilo quadrangle, in the Bighorn basin, was continued by D. F. Hewett, who mapped the remaining 130 square miles in detail with respect to the coal, oil, and gas resources. The land has been classified, and a preliminary report on the chances for finding oil and gas in the quadrangle is in preparation.

A report by Mr. Hewett on the prospects for oil and gas in the Oregon Basin and Meeteetse quadrangles has been submitted, and a report on the coal resources of the quadrangles is in process of preparation.

The Cretaceous sections at Kemmerer and Cumberland were studied by T. W. Stanton, who joined C. F. Bowen in a review of the stratigraphy in part of the Walcott quadrangle. The stratigraphic relations of the Bighorn dolomite and Jefferson limestone were described in a manuscript by Edwin Kirk.

A popular description of the fossil forest of the Yellowstone National Park was prepared by F. H. Knowlton for publication by the Department of the Interior.

#### CANAL ZONE.

In order to procure data for the determination and correlation of some of the formations on the Canal Zone, collections of Tertiary fossils were forwarded by the Isthmian Canal Commission to the Geological Survey. These fossils have been determined and reported on by W. H. Dall.

In continuance of the geologic and paleontologic investigations carried on in cooperation with the Isthmian Canal Commission the fossil calcareous algæ have been reported on by Dr. Marshall A. Howe, who has in preparation other scientific contributions based on the materials from the isthmian region.

## HAWAIIAN ISLANDS.

The manuscript of a report by Whitman Cross on the lavas of the Hawaiian Islands and their relations has been revised and enlarged by the author and is in press as Professional Paper 88.

Collections of Tertiary or Quaternary invertebrates from the islands have been examined and reported on by W. H. Dall.

## INVESTIGATIONS OF A GENERAL NATURE.

In addition to projects relating to specific or restricted areas, the geologic work of the Survey embraces many kinds of research concerning broad provinces or problems, in which the criteria originate in a number of States and the solution of which may have important economic application in many States, though the immediate results are classed as purely scientific. Mention can be made of but a few among the more important or general of these broad researches. Most of the investigations carried on by the Survey are either directly contributory to or are by-products of such studies.

Among the best known of these general studies are those relating to paleontology. The work of the geologists who are specialists in paleontology has a purely scientific side that is biologic and deals with the history of life on the earth and the classification and description of the forms of animals and plants that have been preserved in the rocks. In its geologic aspect, on the other hand, it is indirectly utilitarian, for it is indispensable to the geologic mapping of the country. This side of the work, which is necessarily emphasized by the Survey, touches the classification and correlation of practically all the sedimentary formations mapped by the geologists. From either point of view it involves the comparison of fossils and living faunas and floras in all parts of the world. The areas that must be considered are therefore coextensive with and stretch beyond the field of operations of the Survey as a whole. In illustrating this it may be noted, in passing, that one of the Survey geologists, distinguished for his paleontologic knowledge, has during the year been officially called upon to examine and report on collections of fossils from 18 States, Alaska, the Canal Zone, the Hawaiian Islands, and 10 foreign countries. The examinations of the history and work of the great Pleistocene ice sheets in North America, by Chamberlin and others; the skillful unraveling of the sequence of formations and of the geologic history of the metamorphic belt in the Appalachian region, by Keith and his associates; the working out of the geologic history and physiography of the San Juan region of Colorado, by the Cross and Atwood parties; and the geophysical investigations carried on in the physical laboratory, as noted on pages 82-85, are familiar examples.

The final publications, some of them monographic in scope, may embrace the scientific results of years of study.

Among the more important scientific studies to which special attention has recently been given by the Survey the following may be mentioned:

1. Studies of the precipitative action of metallic minerals on silver in solution. The field investigations carried on by E. S. Bastin and Chase Palmer in Colorado mining districts, and the laboratory experiments by Mr. Palmer, who has made a series of quantitative studies of the action of solutions of silver salts on metallic minerals that are common in silver ores, clearly demonstrate the importance of downward enrichment in the development of rich silver ores. These studies show also that many mineral substances which appear homogeneous and have been described as single mineral species are in reality microscopic mixtures of two or more minerals.

2. The metallographic study of certain ores, which, in accordance with a cooperative arrangement with the Bureau of Mines, was undertaken by one of the geologists of the Survey, F. B. Laney, the material used being drawn mostly from Leadville and other points in Colorado. It has already been shown that much of the banding so characteristic of the Leadville ores was developed by diffusion, during their deposition. It has also been demonstrated that eutectic structures similar in all respects to those characteristic of melts are equally characteristic of certain Leadville ores which are replacement deposits and were formed by precipitation from aqueous solutions; further, that a number of lead-silver-bismuth sulphides, previously regarded as definite minerals, are in reality merely mechanical mixtures of two or more definite, well-known minerals. These facts all have an important bearing on the physics and chemistry of ore deposits, and as soon as further chemical work can be done they will be discussed for publication.

3. Observations of temperatures in deep wells and deep mines. This work is timely by reason of the very deep borings that are now in progress in different parts of the United States and is done not only to ascertain actual temperature gradients in different regions and geologic formations and to obtain criteria for use in studies of isostasy, but also to test a theory, which has gained much credence, that the temperature gradient is steepest in areas underlain by deposits of oil or coal.

4. The study of marine rock deposition in the Florida region, prosecuted by Mr. Vaughan, the extension of whose investigations to the Bahama Islands has been made possible through the cooperation of the Carnegie Institution. Incidental to these studies, which are intended to aid in writing the last chapter in the geologic history of the Coastal Plain, mention may be made of a by-product of the

investigation, the study of the formation of oolites. Verifying and continuing the observations of Drew, Mr. Karl F. Kellerman, of the Bureau of Plant Industry, Department of Agriculture, informally cooperating with Mr. Vaughan, has shown that oolites may be formed in pure cultures through the action of two determined species of bacteria.

5. Chemical analyses, made under the direction of F. W. Clarke, of the carbonates contained in the skeletons, or hard parts, of a number of types of echinoderms. These analyses, which show a relatively high proportion of magnesium carbonate in the organisms examined, especially in those found in warm waters, may ultimately shed light upon the origin of some magnesian limestones, but any definite conclusions on this subject will be premature. This investigation is being continued.

6. The study of the Pleistocene deposits and terraces of the lower Mississippi Valley, begun in 1912 by E. W. Shaw for the purpose of correlating these terraces with the Pleistocene deposits of the glaciated regions to the north and in order to unravel the Pleistocene history of the Coastal Plain. Connected with these investigations is the study of the depositing sediment in the Delta of Mississippi River, a study that relates to the filling of the channels and the flooding of the lowlands, to the chemical changes in the suspended mineral matter and to the deposition of metals and other substances in solution on encountering brackish or salt waters, to the origin of the mud lumps and mud geysers in the delta, and to other interesting matters.

7. The investigation of the movement of water in oil sands and of the great damage caused in some of the California oil fields by the invasion of water, undertaken in informal cooperation with the Bureau of Mines. This investigation made practicable in April the initiation of a long-contemplated inquiry into the general subject of the mutual relations of oil, gas, and water in rocks of different texture and composition and of their movements under varying conditions of structure, etc. This problem, which is likely to prove long and difficult, should afford results of great economic importance as to the practical location of oil and gas pools, as well as to the conservation of these most valuable fuel resources. The problem is inseparably connected also with the question of the origin of petroleum and natural gas.

8. The investigation of the question whether portions of the Atlantic coast of the United States are now slowly subsiding beneath the ocean, by Charles A. Davis, who has several times been transferred from the Bureau of Mines to the Survey for the purpose of prosecuting examinations pertaining mainly to this subject. The presence of deposits both of fresh-water peat and of brackish or salt-



water peat, each kind being clearly distinguished by its component vegetal species in many of the peat bogs along the coast, and the relations of these deposits to the present tide level afford convincing and interesting evidence bearing directly upon this problem.

9. The examination, in cooperation with the Geological Survey of Iowa, of the so-called Iowan drift in the upper Mississippi Valley, undertaken in June by W. C. Alden for the purpose of determining the validity of the so-called Iowan glacial stage and the relations of the Iowan to other Pleistocene deposits in the region.

#### AREA GEOLOGICALLY SURVEYED IN THE UNITED STATES DURING THE YEAR.

On account of differences in the nature of the work performed, it is difficult to estimate areas covered by all the geologists in square miles of detailed areal, detailed reconnaissance, and reconnaissance mapping. However, calculations, omitting examinations for inspection, revision, local studies, etc., furnish the following results for the fiscal year ended June 30, 1914:

##### *Areas covered by geologic surveys, fiscal year 1913-14.*

States east of the one hundredth meridian:	Square miles.
Detailed areal .....	4,100
Detailed reconnaissance .....	1,200
Reconnaissance .....	39,900
States west of the one hundredth meridian:	
Detailed areal .....	7,783
Detailed reconnaissance .....	8,135
Reconnaissance .....	7,940
Total in the United States:	
Detailed areal .....	11,883
Detailed reconnaissance .....	9,335
Reconnaissance .....	47,840

A statement of the areas surveyed by the division of Alaskan mineral resources will be found in the account of the work of that division.

#### DIVISION OF ALASKAN MINERAL RESOURCES.

##### CLASSES OF WORK.

The fact that the appropriation for the continuation of the investigation of the mineral resources of Alaska was not made until June 23, 1913, much curtailed the field season of several of the parties and thereby greatly increased the cost of the work. Out of 14 field parties only 5 performed a full season's work. The loss in time due to the delay in the appropriation amounted to an average of one month, or 29 per cent, for each of 9 field parties. A careful estimate, based on the allotments to these parties and the cost of the additional month of field work, shows that the actual monetary



loss occasioned by the delay—that is, expenditure for which there was no return—was \$7,120, or over 7 per cent of the total fund. The delay of the field work and consequent change of plans also caused a loss of efficiency which can not be expressed in figures. It can be stated, however, that the delay in appropriation for two successive years<sup>1</sup> has put the Alaska field work nearly one year behind. This is indicated by the table showing progress of surveys (p. 77).

Under the appropriation of \$100,000 made for the continuation of the investigation of the mineral resources of Alaska, as in previous years, the following classes of work were carried on: Reconnaissance and detailed geologic surveys, special investigations of mineral resources, reconnaissances and detailed topographic surveys, investigation of water resources with reference to their use in mining, and collection of statistics on mineral production.

#### PERSONNEL.

The personnel of the division varied somewhat during the year on account of transfers of employees to and from other divisions and temporary employment of technical assistants. On July 1, 1913, the division included 1 geologist in charge, 9 geologists, 4 topographers, 2 engineers, 3 clerks, and 1 draftsman on annual salaries, and 2 field assistants and 13 camp hands and recorders. On June 30, 1914, the personnel of the division included 1 geologist in charge, 11 geologists, 4 topographers, 1 draftsman, and 3 clerks on annual salaries, and 2 field assistants and 22 camp hands and recorders. One geologist employed for three months and one employed for six weeks during the year were not included in the above enumeration.

#### FIELD OPERATIONS IN SEASON OF 1913.

*Areas covered and allotments.*—Fourteen parties in all were engaged in surveys and investigations during 1913. Two of these started field work in May, three in June, seven in July, and two in August. The average length of the Alaskan field season is 110 days; the average time of all the parties in 1913 was 73 days.

The areas covered by geologic exploratory surveys on a scale of 1:500,000 (8 miles to the inch) amount to 3,500 square miles; by geologic reconnaissance surveys, scale 1:250,000 (4 miles to the inch), 2,950 square miles; by detailed geologic surveys, scale 1:62,500 (1 mile to the inch), 180 square miles. Much of the time of the geologists was devoted to special field problems, the result of which can not be expressed areally. Topographic exploratory surveys on a scale of 1:500,000 covered about 3,400 square miles; topographic reconnaissance surveys, 2,535 square miles; detailed topographic sur-

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<sup>1</sup> The full appropriation for 1912-13 was not available until Aug. 24, 1912.

veys, 287 square miles. Twenty-five stream-gaging stations were maintained for an average of 12 weeks each in south-central Alaska.

The following table shows the allotment, including both field and office expenses, to the different regions investigated. The results are expressed in round numbers. "General investigations" include, among other things, the cost of collecting mineral statistics and of office work relating to the field investigations of previous seasons:

*Approximate geographic distribution of appropriation for Alaskan work, 1913.*

Southeastern Alaska.....	\$7,000
Yakataga region.....	6,000
Copper River.....	10,500
Prince William Sound.....	7,000
Kenai Peninsula.....	1,500
Susitna basin.....	25,500
Matanuska basin.....	23,500
Yukon basin.....	8,500
General investigations.....	4,500
Unallotted .....	6,000
	<hr/> 100,000

In the following tables the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same man may have carried on different kinds of work, but these tables will serve to elucidate a later table, which will summarize the complete areal surveys.

*Approximate allotments to different kinds of surveys and investigations, 1913.*

Geologic and topographic exploration.....	\$4,650
Reconnaissance geologic surveys.....	17,450
Detailed geologic surveys.....	5,350
Special geologic investigations.....	11,100
Reconnaissance topographic surveys.....	7,400
Detailed topographic surveys.....	20,700
Investigation of water resources.....	6,300
Collection of statistics of mineral production.....	1,250
Miscellaneous, including administration, inspection, clerical salaries, office supplies, and equipment.....	19,800
Unallotted .....	6,000
	<hr/> 100,000

*Allotments for salaries and field expenses, 1913.*

Scientific and technical salaries.....	\$38,800
Field expenses.....	38,930
Clerical and other office and miscellaneous expenses.....	16,270
Unallotted .....	6,000
	<hr/> 100,000

*Progress of the work.*—The following table exhibits the progress of investigations in Alaska and the annual appropriations since systematic surveys were begun in 1898. A varying amount is expended each year on special investigations, yielding results which can not be expressed in terms of area.

*Progress of surveys in Alaska, 1898-1913.*



\* The Coast and Geodetic and International Boundary surveys have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

*General work.*—Alfred H. Brooks, geologist in charge, spent the month of July in Alaska. He visited several points on Cook Inlet and spent about 10 days with B. L. Johnson in reviewing the geology of the Ellamar district and adjacent regions. Mr. Brooks attended the Thirteenth International Geological Congress at Toronto, August 7 to 14, as an official delegate, and later made an excursion through the Canadian Cordillera, visiting a number of mining camps in British Columbia.

Of the 222 days spent by Mr. Brooks in office work during the fiscal year, 38 were devoted to scientific investigations, 24 to writing articles for the progress report, 10 to preparing the annual press bulletin on the mining industry of Alaska, 8 to compiling statistics on mineral production, 12 to preparing field plans, 16 to matters

relating to Alaska railroads and to coal-land leasing, and 8 to preparations for the Panama-Pacific Exposition. The rest of his time was devoted to routine and miscellaneous matters.

R. H. Sargent continued the general supervision of the topographic surveys and map compilation, in addition to carrying on his own field work. E. M. Aten continued to serve as office assistant and during the absence of the geologist in charge and of the three senior geologists acted as administrative head of the division. He also continued to assist in collecting statistics of production of precious metals in Alaska. Arthur Hollick was employed for about six weeks, and continued the study of the coal measures of Alaska.

*Southeastern Alaska.*—Field work in the Ketchikan district was carried on by P. S. Smith from May 12 to July 25, when he returned to Washington to take charge of the Alaska division. Much new information on the areal geology and stratigraphy was gained, but further field studies will be made before the results are published.

Mr. E. F. Burchard completed the reconnaissance of most of the marble deposits of the Juneau and Sitka districts. He was in the field from August 28 to October 3.

*Yakataga region.*—A fairly complete reconnaissance of the gold and oil bearing district of the Yakataga region was made and some of the coal beds were examined. The reconnaissance surveys covered an area of about 1,000 square miles.

A. G. Maddren, assisted by E. O. Blades and one boatman, reached Yakataga on July 13 and continued field work until September 13. Mr. Blades did some work in this region until October 14. In the Yakataga district the party traveled chiefly on foot, carrying their supplies on their backs. In spite of this arduous work and the obstacles of heavy vegetation and glacial streams, reconnaissance surveys were in places carried inland for some 15 miles.

*Copper River region.*—The detailed topographic survey of the Kuskulana district was completed by D. C. Witherspoon. The map of this district will be published on a scale of 1 mile to the inch, with 100-foot contours. In 1913 about 95 square miles was mapped, in spite of the fact that field work was not begun until July 18. Work was continued, so far as weather permitted, until October 19.

In connection with the work in the Susitna basin (p. 81), J. W. Bagley surveyed a belt adjacent to the Government wagon road extending from Beaver Dam to Gulkana. C. E. Giffin, while waiting for the appropriation bill to be passed, made a similar survey along the wagon road from Beaver Dam to Valdez. The investigation of the water resources of the Copper River basin below Copper Center is described under "Prince William Sound." below.

*Prince William Sound.*—Field work in the Prince William Sound region was begun on July 13 by B. L. Johnson, and included a re-

examination of some localities in the Ellamar district. Mr. Johnson also spent about two months in making a reconnaissance of the gold deposits of the Port Wells district and some further studies of the Port Valdez district and of Latouche Island, finishing his field work October 27.

C. E. Giffin utilized a part of the time while waiting at Valdez for the appropriation bill to be passed in making a hurried topographic reconnaissance from the head of Passage Canal to Turnagain Arm.

A preliminary study of the possibilities of developing water power in the Prince William Sound region and adjacent portions of the Copper River and Bering River areas, Kenai Peninsula, and the Willow Creek district was undertaken in 1913 by C. E. Ellsworth and R. W. Davenport. Work was begun on May 5 and continued until November 25. In the Bering River region only four days was spent in actual work, and six measurements of stream flow were made. The work in the Copper River basin was extended northward as far as Copper Center and eastward on the Chitina as far as the Nizina placer district. Four gaging stations were maintained for an average of 17 weeks each and 46 measurements of stream flow were made. One rainfall station was established. In the Prince William Sound region 10 gaging stations were maintained for an average of 12 weeks each and 82 measurements of stream flow were made. In Kenai Peninsula and the Willow Creek district 10 gaging stations were maintained for an average of 10 weeks each and 51 measurements of stream flow were made.

*Willow Creek district.*—A detailed topographic and geologic survey of Willow Creek district was undertaken in 1913. The base map was made by C. E. Giffin, who began work on July 14 and completed the survey on August 27. In this time an area of 90 square miles was surveyed for publication on a scale of 1 mile to the inch, with 100-foot contours. The geology of the same area was mapped on the same scale by S. R. Capps, who began work on July 14 and finished on September 16. His work included also a detailed study of the ore deposits.

*Broad Pass region.*—Topographic surveys of the Broad Pass region were made by J. W. Bagley, by phototopographic methods. After a long journey from the coast Mr. Bagley began field work on July 9 and continued it until August 23. Some 2,500 square miles was surveyed for publication on a scale of 4 miles to the inch, with 200-foot contours. F. H. Moffit and J. E. Pogue made a geologic reconnaissance survey of a part of the same area. They began field work on June 29 and continued until August 28, covering an area of 800 square miles.

*Matanuska basin.*—A base map of 102 square miles in the upper Matanuska basin was made by R. H. Sargent for publication on a scale of 1 mile to the inch, with 50-foot contours. He was assisted by R. W. Chaney and began field work on July 22 and finished on September 26. The geologic work was done by G. C. Martin, assisted by J. B. Mertie, jr., and R. M. Overbeck. This party began field work on July 14 and finished on October 9. It was originally planned that a detailed geologic survey of the entire Matanuska coal field should be made, but as the party was necessarily a month late in reaching the field, this plan proved impracticable and therefore only the areas of actual coal outcrops were studied in detail. At the same time a reconnaissance was extended over a large area to determine the general distribution of the coal measures as well as of the other formations.

*Yukon-Koyukuk region.*—A geologic and topographic exploration was carried on by H. M. Eakin from a point near the mouth of Dall River southwestward to the Koyukuk, passing through the Indian River placer district. On his return Mr. Eakin traveled in a southerly direction, reaching the Yukon near the mouth of Melozi River. This survey was carried on from June 19 to August 20, and covered an area of about 2,400 square miles, for publication on a scale of 8 miles to the inch.

*Fairbanks district and Seward Peninsula.*—The progress in quartz mining at Fairbanks led to further studies of this field by Theodore Chapin. He arrived at Fairbanks on August 12 and continued his work until August 31. He then proceeded to Nome and made an investigation of the mining developments on Seward Peninsula. This work occupied him until October 8.

#### FIELD OPERATIONS FOR SEASON OF 1914.

Alfred H. Brooks will continue investigations of placer deposits in different parts of Alaska.

G. C. Martin, assisted by R. M. Overbeck, is continuing his studies of Mesozoic stratigraphy in many parts of Alaska.

Further investigations of Alaska tin deposits, of the auriferous lodes of Seward Peninsula, and of the Fairbanks and Juneau districts will be made by H. M. Eakin.

A new topographic base map of the region adjacent to Juneau, on a scale of 1:24,000, is in progress by D. C. Witherspoon.

A geologic and topographic reconnaissance survey is being carried on by Stephen R. Capps and C. E. Giffin across Skolai Pass to the newly discovered Chisana placer district. The previous surveys in this field will be extended and supplemented.

Detailed geologic surveys and studies of the ore deposits of the copper-bearing area adjacent to Kuskulana River are being made by F. H. Moffit, assisted by J. B. Mertie.

Detailed geologic surveys and investigations of the mineral resources of the Port Valdez mining district, by B. L. Johnson, assisted by G. L. Harrington, are under way.

Geologic and topographic reconnaissance surveys, by J. W. Bagley and Theodore Chapin, are in progress in the headwater regions of Talkeetna and Susitna rivers.

A geologic and topographic reconnaissance survey from Lake Clark to the Iditarod district is being made by R. H. Sargent and P. S. Smith, and A. G. Maddren is on the way to the lower Kuskokwim Valley, where he will investigate the gold-placer districts.

#### COLLECTION OF STATISTICS.

The work of collecting statistics of the annual production of gold, silver, and copper in Alaska, begun in 1906, was continued during the year. The progress report for 1913 was completed in June and is in press as Bulletin 592. This report contains figures on mineral production which were also included in a report transmitted in June for inclusion in the Survey's annual volume, "Mineral Resources of the United States," for the calendar year 1913.

#### OFFICE WORK.

During the year six bulletins (Nos. 525, 526, 533, 536, 538, and 542) were issued relating to Alaska. One professional paper (No. 87), four bulletins (Nos. 576, 578, 587, and 592), and one water-supply paper (No. 342) are in press. All these publications contain maps. A detailed topographic map (Port Valdez district, scale 1:62,500) is in press. Manuscripts of the following reports have been completed:

The Ellamar district, Alaska, by S. R. Capps and B. L. Johnson, including detailed geologic and topographic maps.

The Willow Creek district, Alaska, by S. R. Capps, including detailed geologic and topographic maps.

The Broad Pass region, Alaska, by F. H. Moffit and J. E. Pogue, including geologic and topographic reconnaissance maps.

A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. E. Davenport.

The following reports are in hand:

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. Wright and C. W. Wright, including geologic reconnaissance map.

Geology of the region along the international boundary from Porcupine River to the Arctic Ocean, by A. G. Maddren, including detailed geologic map.

The upper Matanuska basin, by G. C. Martin and J. B. Mertie, including geologic and topographic reconnaissance and detailed maps.

The Yukon-Koyukuk region, by H. M. Eakin, including geologic and topographic reconnaissance maps.



The office work on eight topographic maps was completed during the year, as follows:

Port Valdez and vicinity, by J. W. Bagley, scale 1:62,500, contour interval 100 feet.

Yukon-Tanana region (compiled map), scale 1:500,000 (drainage map).

Yukon-Koyukuk region, by H. M. Eakin, scale 1:500,000, contour interval 200 feet.

Yakataga region, by A. G. Maddren, scale 1:500,000, contour interval 200 feet.

Upper Matanuska basin, by R. H. Sargent, scale 1:62,500, contour interval 100 feet.

Ellamar and vicinity, by R. H. Sargent and C. E. Giffin, scale 1:62,500, contour interval 100 feet.

Willow Creek district, by C. E. Giffin, scale 1:62,500, contour interval 100 feet.

Passage Canal to Turnagain Arm, by C. E. Giffin, scale 1:62,500, contour interval 100 feet.

General map of Alaska (new edition), scale 1:500,000.

The following maps are in hand:

Broad Pass region, by J. W. Bagley, scale 1:250,000, contour interval 200 feet.

Kuskulana district, by D. C. Witherspoon, scale 1:62,500, contour interval 100 feet.

General map of Alaska, scale 1:250,000.

#### SCIENTIFIC RESULTS.

Mr. Johnson obtained evidence that some of the sediments in the Port Wells district of Prince William Sound are of Mesozoic age. Mr. Moffit and Mr. Pogue found Middle Devonian limestones in the Broad Pass region. They also brought definite proof of the Eocene age of the Cantwell formation, which had previously been provisionally assigned to the Carboniferous. Some evidence was also found of the presence of post-Eocene lignite-bearing sediments in the same field. Mr. Maddren observed in the Yakataga region the occurrence of phyllite of Pleistocene age which had been involved in the folding of the front range of the St. Elias chain. Mr. Eakin found that a large amount of granite had been intruded into the Mesozoic sediments of the Yukon-Koyukuk region, thus furnishing additional proof that the massive intrusive rocks of the Yukon basin are chiefly of Mesozoic age.

#### DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

This division is in charge of George F. Becker, geologist, who has immediate direction of geophysical researches. The force in the chemical laboratory forms essentially a section in charge of F. W. Clarke, chief chemist.

The routine and administrative work of the division has largely occupied the time of Mr. Clarke, who nevertheless has been able to prepare a new edition of Bulletin 419 on rock and mineral analyses, now in the printer's hands, and, in collaboration with W. C. Wheeler, a paper on the composition of crinoid skeletons. This paper is printed in "Shorter contributions to general geology, 1914" (Professional Paper 90).

A paper on the relative abundance of certain metallic elements, especially copper, lead, zinc, arsenic, and cadmium, by Mr. Clarke and George Steiger, has been published in the Journal of the Washington Academy of Sciences.

The greater part of Mr. Steiger's time has been taken up with routine analyses, notable among which are those of a composite of 235 samples of Mississippi River mud; of water from a deep well at McDonald, Pa., and of a composite of 329 samples of igneous rocks for the determination of traces of lead, copper, nickel, and zinc. Mr. Steiger also made experiments to show the relative solubility of the various kinds of glass used in the chemical laboratory.

Researches involving the application of physico-chemical methods of investigation were prosecuted by R. C. Wells. Mr. Wells completed determinations of the solubility of galena and sphalerite in solutions resembling natural waters in order to assist in elucidating the origin of the Joplin ores. He made determinations of radioactivity of uranium ores by the electroscopic method, partly for geologists and partly for persons outside of the Survey requesting qualitative determinations. He completed the revision of Bulletin 548, "Electric activity in ore deposits," and published short papers entitled: "A new occurrence of cuprodescloizite," "Electrochemical activity between minerals and solutions," and "Electromotive behavior of soluble sulphides."

The relation of certain minerals to the deposition of silver ores and to their enrichment was investigated by Chase Palmer. In connection with these studies Mr. Palmer found an efficient solvent for use in the analysis of arsenides, with which he investigated nickel arsenides from Germany and Canada and harmonized conflicting statements concerning their chemical nature. A paper by Mr. Palmer on tetranickel triarsenide, with respect to its capacity as a precipitant of silver, has been submitted for publication in the journal Economic Geology. The chemical association of gold and silver in the ore of the Republic mine, Washington, is the subject of a manuscript contributed by Mr. Palmer for publication in Bulletin 550; and a report on the qualities of underground waters at Charleston, S. C., has been submitted for publication in Professional Paper 90.

Strictly mineralogic investigations occupied only a part of the attention of Waldemar T. Schaller, much of his time being consumed

in routine work in miscellaneous qualitative mineral and chemical determinations and in quantitative analyses of rocks and minerals. His report "The gem tourmaline field of southern California" was revised, and a report entitled "Mineralogical notes, series 3," was prepared and submitted for publication. This report contains many original papers and descriptions of a number of new mineral species and also establishes better the precise character of other known minerals. Mr. Schaller also analyzed a new zinc manganese silicate from Franklin Furnace, N. J., and several minerals from Colorado, namely, melilite, cebollite (a new mineral, an alteration product of melilite), blue anatase, and a titaniferous garnet.

Phosphate rocks from numerous sources were analyzed by W. C. Wheeler, who also made the analyses of the crinoids which formed the basis of the paper by F. W. Clarke and himself, published in Professional Paper 90.

Investigations connected with the search for potash deposits in the United States occupied the time of W. B. Hicks and R. K. Bailey. Mr. Hicks was for three months engaged with Mr. Gale in the study of the deposits in Columbus Marsh and Black Rock Desert, Nev., and Searles Lake, Cal. A chemical study was made by him of the muds of Columbus Marsh. The following papers have been prepared by Mr. Hicks: "The action between clay filters and certain salt solutions," "Octahedral sulphohalite" (with H. S. Gale), "Searlesite, a new mineral," and "The muds of Columbus Marsh."

R. K. Bailey assisted Mr. Hicks in analytical investigations, his work consisting mainly of analyses of suspected potash salts, nitrates, and phosphates. He also made some field investigations in the Black Rock Desert region and examined some nitrate deposits in southern California.

In the physical laboratory C. E. Van Orstrand has been assisted by A. F. Melcher and R. Weinstein in investigations of the elasticity of metals and in the construction of mathematical tables. In addition to these investigations, which are to a certain extent routine in character, special apparatus has been designed and constructed for the purpose of determining the temperatures of deep wells by means of maximum thermometers and electrical resistance thermometers. Tests made in the field show that an accuracy of  $0.1^{\circ}$  C. can be obtained, and the time required for taking the necessary measurements for a single well of 3,000 feet depth has been reduced from about four days to five or six hours.

Mr. Becker, chief of the division, continued his investigations in the mechanics of earth slides in the Culebra Cut. He also prepared a short paper on a feature of the nebular hypothesis, and, with A. L. Day, made an investigation of the linear force of growing crystals.

confirming an investigation made several years ago. Progress has also been made in the preparation of two papers, one on isostasy and the other on "Queries on radioactive geology."

#### DIVISION OF MINERAL RESOURCES.

The scope of the work of the division of mineral resources has not been changed during the year, the Survey having continued the policy of making the annual report, "Mineral Resources of the United States," more than a statistical compilation by treating in full the sources from which the mineral products of the country are obtained. This report thus becomes in fact, as well as in name, an annual inventory of the Nation's mineral resources.

During the last 11 years the reports have been prepared in large part by geologists of the Survey who have specialized in the subjects treated by them, with a view to carrying out the provision of the organic act of the Survey which directs the examination of the mineral resources and products of the national domain.

Cooperation between the Geological Survey and the State surveys in collecting most of the mineral statistics continued in force in the preparation of the report for 1913. The 18 States which cooperated were Alabama, Florida, Georgia, Illinois, Iowa, Kansas, Maryland, Michigan, Missouri, New Jersey, New Mexico, North Carolina, Oklahoma, Oregon, Pennsylvania, Virginia, Washington, and Wisconsin. The results of this cooperation for 1913 have been the most satisfactory yet obtained. The method employed obviates the duplication of a considerable amount of work and, so far as applied, saves the producers the annoyance of preparing two sets of statistical returns.

During the fiscal year the work of the division consisted of the preparation of the reports on the mineral production of the United States in the calendar years 1912 and 1913. The report for 1912 was published in two parts. Part II (Nonmetals) was issued in December, 1913, and Part I (Metals) in January, 1914. Work on the report for 1913 was well advanced at the close of the fiscal year. The energies of the entire force of the division have been directed to the prompter publication of the reports, as well as to obtaining more complete information regarding the mineral industries, especially the sources of production. At the close of the fiscal year 1913 the manuscripts of 34 chapters from the report for the calendar year 1912 had been completed and transmitted to the printer. On June 30, 1914, 33 chapters for the report for 1913 had been completed and transmitted to the printer.

Preliminary estimates of the production of the following minerals in 1913, with reviews of the conditions that prevailed during the year, were given to the press in the form of special press bulletins during the later part of December, 1913, and in January, 1914:

Arsenic, cement, coal, copper, gold and silver mining, iron ores, lead, petroleum, quicksilver, radium ores, rutile, tin, tungsten ores, uranium ores, vanadium ores, western metal mining, and zinc. Advance statements giving the final figures covering the production of copper, lead, and zinc in 1913 have also been published. Separate chapters from the report for 1913 on the following subjects (33 in all) have been published or are in press: Abrasives; anthracite; asbestos; barytes; bauxite and aluminum, cement; chromic iron ore; feldspar; fluorspar and cryolite; fuel briquetting; fuller's earth; gold, silver, copper, and lead in South Dakota and Wyoming; gold, silver, copper, lead, and zinc in the Eastern States; graphite; gypsum; lime; manganese; mica; mineral paints; mineral waters; phosphate rock; potash salts; pottery; quicksilver; salt and bromine; sand and gravel; sand-lime brick; secondary metals; silica; silver, lead, copper, and zinc in the Central States; slate; sulphur and pyrite; and talc and soapstone.

The number of permanent employees in Washington who devote their entire time to the work of the division of mineral resources is 31, and 8 persons are employed in the offices of the division outside of Washington—at Salt Lake City, Denver, and San Francisco. In addition to these employees, 21 members of other divisions of the Survey, chiefly geologists; devote a part of their time to the work of the division of mineral resources, making a total of 60 persons employed in the work.

During the year 189,122 pieces of first-class mail matter (chiefly statistical inquiries) were sent out by the division, an increase of 20 per cent over 1913, and 69,368 pieces were received.

E. W. Parker continued as administrative head of the division and chief of the section of nonmetallic resources. H. D. McCaskey continued as geologist in charge of the section of metallic resources, and on January 15 was placed temporarily in charge of the division to permit Mr. Parker to devote half of his time (on leave without pay) during the remainder of the fiscal year to work on a history of the mining industry, prepared for the department of economics and sociology of the Carnegie Institution of Washington. During the part of this period that Mr. Parker was on official duty he prepared for publication by the Survey the reports on the production of coal, the manufacture of coke, and the fuel-briquetting industry. The reports on the several mineral products were in charge of the persons indicated below: E. S. Bastin, graphite; E. F. Burchard, cement, fluorspar and cryolite, stone, iron ore, pig iron, and steel; B. S. Butler, copper (general report), copper and silver in Michigan (mines report); A. T. Coons, slate; C. A. Davis (of the Bureau of Mines), peat; D. T. Day, asphalt and bituminous rock, natural gas, petroleum, platinum and allied metals; J. S. Diller, asbestos, chro-

mite, talc and soapstone; R. B. Dole, mineral waters; J. P. Dunlop, silver, copper, lead, and zinc in the Central States (mines report), secondary metals, metals and ores (summary report); H. S. Gale, borax, magnesite, nitrates; F. L. Hess, antimony, arsenic, bismuth, cobalt, molybdenum, nickel, selenium, tantalum, tungsten, titanium, vanadium, uranium, tin; D. F. Hewett, manganese; J. M. Hill, barytes, mineral paints, strontium ore; F. J. Katz, abrasives, feldspar, silica (quartz); H. D. McCaskey, gold and silver (general report), gold, silver, copper, lead, and zinc in the Eastern States (mines report), quicksilver; Jefferson Middleton, clay, clay-working industries, fuller's earth, sand-lime brick; W. C. Phalen, bauxite and aluminum, phosphate rock, potash salts, salt and bromine, sodium salts, sulphur and pyrite; C. E. Siebenthal, lead, zinc, and cadmium (general report); D. B. Sterrett, gems and precious stones, mica; R. W. Stone, glass sand, other sand, and gravel, gypsum, lime; W. T. Thom, summary of the mineral production; C. G. Yale (with H. S. Gale), borax, magnesite.

In addition to preparing his reports and performing supervisory work in Washington, Mr. McCaskey exercises general supervision of the offices of the division in the Western States. The offices at Denver, Salt Lake City, and San Francisco are under the direct charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, respectively, who prepare the various mines reports on gold, silver, copper, lead, and zinc in the Western States.

## TOPOGRAPHIC BRANCH.

### ORGANIZATION.

The organization of the topographic branch remained the same as at the close of the last fiscal year and is as follows:

Chief geographer, R. B. Marshall.

Atlantic division, Frank Sutton, geographer in charge.

Central division, W. H. Herron, geographer in charge.

Rocky Mountain division, Sledge Tatum, geographer in charge.

Northwestern division, T. G. Gerdine, geographer in charge.

Pacific division, George R. Davis, geographer in charge.

Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman, topographic engineer.

### PERSONNEL.

The technical corps of the topographic branch was increased during the year by the appointment of 9 junior topographers and the reinstatement of 1 topographic engineer, 2 assistant topographers, and 1 junior topographer. It was reduced 13 by transfers and resignations. With these changes the technical force now includes 1 chief geographer, 11 geographers, 23 topographic engineers, 31 topographers, 37 assistant topographers, 55 junior topographers, and 8 drafts-



men—a total of 166. In addition, 47 technical field assistants were employed during the whole or a part of the field season. One geographer, 1 topographic engineer, and 1 assistant topographer are on leave without pay; and 2 topographers, 3 assistant topographers, and 6 junior topographers were furloughed.

PUBLICATIONS.

The published work of the topographic branch for the fiscal year consists of 102 maps and 10 book publications, namely, “Results of triangulation and primary traverse, 1911 and 1912”; “Results of triangulation and primary traverse in Ohio, 1898 to 1911, inclusive”; and bulletins giving results of spirit leveling in Illinois, Kentucky, Indiana, Oregon, Washington, Wyoming, Oklahoma, and Kansas. Brief summaries of these publications (Bulletins 551–558, 564, and 571) are given on page 23. Manuscript for level results in Arizona from 1899 to 1913, inclusive, was transmitted for publication, and level results for 1913 work were added to the manuscripts for bulletins previously transmitted for the following States: Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Minnesota, Missouri, Nebraska, Oklahoma, Oregon, Utah, Virginia, Washington, Wisconsin, Wyoming, and the Territory of Hawaii.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1914 were:

Topographic surveys.....	\$350, 000
Surveying national forests.....	75, 000
Statutory salaries.....	9, 200
	<hr/>
	434, 200

The allotments of the appropriations, which were adhered to so far as practicable, were as follows:

*Allotments from funds appropriated for topographic work, fiscal year 1914.*

	Topo- graphic surveys.	Surveying national forests.
Administrative expenses of Survey.....	\$22, 896	\$4, 500
Clerical assistance and supervision.....	16, 542	3, 388
Map editing.....	6, 225	1, 275
Purchase and repair of instruments, stationery, etc.....	12, 242	2, 508
Millionth scale map.....	20, 000	.....
Atlantic division, field work in Alabama, Maine, New York, North Carolina, Penn- sylvania, Vermont, Virginia, and West Virginia.....	61, 725	.....
Central division, field work in Illinois, Indiana, Iowa, Kentucky, Michigan, Minne- sota, Missouri, Ohio, and Wisconsin.....	60, 000	.....
Rocky Mountain division, field work in Colorado, Montana, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming.....	31, 543	28, 200
Northwestern division, field work in Idaho, Oregon, and Washington.....	50, 872	20, 320
Pacific division, field work in Arizona, California, Nevada, Utah, and Hawaii.....	65, 955	14, 000
Work by land-classification board.....	11, 000	3, 000
	<hr/>	<hr/>
	359, 000	75, 200



## COOPERATION.

Cooperation has been maintained with several States, as described in previous reports. The States and the amounts allotted by them are as follows:

*Allotments for cooperative topographic work.*

California.....	\$16,500.00	Oklahoma.....	\$1,000.00
Illinois.....	11,500.00	Oregon.....	18,000.00
Iowa.....	1,750.00	Pennsylvania.....	6,816.55
Kentucky.....	10,000.00	Vermont.....	2,000.00
Maine.....	4,900.00	Virginia.....	4,250.00
Michigan.....	2,500.00	Washington.....	12,500.00
Minnesota.....	10,000.00	West Virginia.....	14,331.41
Missouri.....	10,000.00	Hawaii.....	16,000.00
Nebraska.....	2,000.00		
New York.....	10,000.00		179,047.96
Ohio.....	25,000.00		

Additional allotments of \$500 and \$550 were also made by the States of Missouri and Washington, respectively, for cooperation in the compilation of the Missouri and Washington portions of the 1:1,000,000 scale map of the United States. These funds were met by Federal allotments of equal amounts.

## GENERAL OFFICE WORK.

Progress maps were kept up to date and new ones were compiled when necessary; the new 1:1,000,000 State maps were used when available; results of computations for vertical and horizontal control work were copied and catalogued, and 128 examination papers for the junior topographer and topographic aid civil-service examinations were rated.

The computations of control data were made principally by D. H. Baldwin, T. M. Bannon, L. F. Biggs, R. H. Chapman, J. R. Ellis, G. T. Hawkins, Oscar Jones, C. B. Kendall, F. J. McMaugh, A. C. Roberts, C. F. Urquhart, and J. H. Wilson under the immediate supervision of E. M. Douglas, geographer. S. S. Gannett, geographer, spent most of his time in preparing manuscript and compiling data for the bulletins submitted for publication.

J. H. Renshawe was engaged in preparing colored relief maps of national parks for the Secretary of the Interior. Such maps have already been prepared for the Crater Lake, Yosemite, Glacier, and Yellowstone national parks, and that for the Mount Rainier National Park is in progress.

## SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1914, distinguished as to scale, etc., is shown on Plate II.

As is shown in the following tables, which give the details of topographic mapping and spirit leveling for the fiscal year, the total new area mapped was 18,808 square miles, making the total area surveyed to date in the United States 1,197,782 square miles, or 39.6 per cent of the entire country. In addition, 4,290 square miles of resurvey was completed, making the total area of actual surveys during the year 23,098 square miles.

In connection with these surveys 5,365 linear miles of primary and precise levels were run, making 247,407 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work 1,326 permanent bench marks were established. In addition, 791 linear miles of river surveys were run.

Triangulation stations to the number of 134 were occupied, and 123 were permanently marked. Primary traverse lines aggregating 2,299 miles were run, in connection with which 273 permanent marks were set. In the course of this work 21,810 square miles was covered by primary control.

The area covered by detailed topographic surveys in Alaska during the fiscal year, as reported on page 77, was 287 square miles, for publication on the scale of 1:62,500.

Topographic surveys were also carried on in Hawaii, the area mapped during the fiscal year being 342 square miles, for publication on the scale of 1:31,680, making the total area surveyed to date in Hawaii 1,374 square miles. In connection with the surveys in Hawaii, 44 miles of primary levels were run and seven permanent bench marks were established, making the total number of miles of primary and precise levels run by this Survey in Hawaii 578.

**THIRTY-FIFTH ANNUAL REPORT PLATE II**

**THE**

*Present condition of topographic surveys of the United States and new areas surveyed July 1, 1913, to June 30, 1914.*

	New area mapped July 1, 1913, to June 30, 1914.	Total area mapped to June 30, 1914.	Percentage of total area of State mapped to June 30, 1914.
	<i>Square miles.</i>	<i>Square miles.</i>	
Alabama.....	33	18,752	36
Arizona.....	1,304	68,064	60
Arkansas.....		21,380	40
California.....	1,672	111,116	70
Colorado.....	2,118	47,344	46
Connecticut.....		4,965	100
Delaware.....		1,202	51
District of Columbia.....		70	100
Florida.....		2,080	4
Georgia.....		17,837	29
Idaho.....	1,036	25,498	30
Illinois.....	884	14,012	25
Indiana.....	209	3,250	9
Iowa.....	162	11,533	21
Kansas.....		64,159	78
Kentucky.....	319	17,973	44
Louisiana.....		8,311	17
Maine.....	296	9,210	28
Maryland.....		12,327	100
Massachusetts.....		8,266	100
Michigan.....	154	5,745	10
Minnesota.....	515	6,087	7
Mississippi.....		1,889	4
Missouri.....	502	36,166	52
Montana.....	641	56,606	39
Nebraska.....	213	26,524	34
Nevada.....	380	51,062	46
New Hampshire.....		3,380	36
New Jersey.....		8,224	100
New Mexico.....	82	35,932	29
New York.....	713	42,940	87
North Carolina.....	647	18,308	35
North Dakota.....		9,716	14
Ohio.....	2,473	37,200	91
Oklahoma.....	156	39,768	56
Oregon.....	893	21,635	22
Pennsylvania.....	479	24,646	55
Rhode Island.....		1,248	100
South Carolina.....		5,640	18
South Dakota.....		18,594	24
Tennessee.....	242	21,153	50
Texas.....	296	67,683	25
Utah.....	385	68,290	80
Vermont.....	213	3,966	41
Virginia.....		29,980	70
Washington.....	1,332	24,601	35
West Virginia.....		24,170	100
Wisconsin.....	144	11,933	21
Wyoming.....	309	27,847	28
	18,808	1,197,782	39.6
Hawaii.....	342	1,374	21

## ATLANTIC DIVISION.

## FIELD WORK.

## SUMMARY.

During the season topographic mapping was carried on in Alabama, Georgia, Maine, Mississippi, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia. This work comprised the completion of the survey of 11 quadrangles, and of the resurvey of 7 quadrangles, in addition to which 5 quadrangles were partly surveyed and 7 were partly

resurveyed. The total new area mapped was 2,629 square miles, for publication on the scale of 1:62,500. The area resurveyed was 2,104 square miles, for publication on the scale of 1:62,500. In connection with this work 1,046 miles of primary levels were run and 262 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by 10 parties, the work being distributed over portions of Alabama, New Jersey, New York, North Carolina, Mississippi, Pennsylvania, and West Virginia. The total area covered by this primary control was about 2,815 square miles, of which 2,147 square miles was controlled by primary traverse, 565 miles being run and 59 permanent marks set. Twenty-six triangulation stations were occupied and 15 were permanently marked. The result of this work was to make control available in 15 quadrangles.

Topographic surveys in Atlantic division from July 1, 1913, to June 30, 1914.

State.	Con- tour inter- val.	For publication on scale of 1:62,500.		Total area sur- veyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Re- survey.		Dis- tance run.	Bench marks.	Dis- tance run.	Perma- nent marks.	Stations occu- pied.	Stations marked.
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>			
Alabama.....	20	39	.....	39	58	16	142	15	.....	.....
Georgia.....	50	.....	207	207	90	23	.....	.....	.....	.....
Maine.....	20	296	60	356	174	49	.....	.....	.....	.....
Mississippi.....	.....	.....	.....	.....	.....	.....	127	13	.....	.....
New Jersey.....	20	.....	21	21	.....	.....	5	.....	2	.....
New York.....	20	713	.....	713	173	40	69	6	13	8
North Carolina....	20	647	.....	647	165	32	170	20	.....	.....
Pennsylvania.....	20	479	214	693	54	16	28	2	8	7
Tennessee.....	20	242	.....	242	74	20	.....	.....	.....	.....
Vermont.....	20	213	.....	213	70	14	.....	.....	.....	.....
Virginia.....	50	.....	427	427	79	21	.....	.....	.....	.....
West Virginia.....	50	.....	1,175	1,175	109	28	24	3	3	.....
.....	.....	2,629	2,104	4,733	1,046	262	565	59	26	15

DETAILS OF WORK BY STATES.

Alabama.—The State geologist of Alabama allotted \$10,000 to carry out unfinished cooperative work begun in 1911-12. A portion of the new State funds was made available in the spring of 1914, and the survey of the Florence quadrangle, in Colbert and Lauderdale counties, was commenced by C. E. Cooke, the area mapped being 39 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

In addition to this cooperative work, H. S. Senseney ran 78 miles of primary levels and established 16 permanent bench marks for the control of the Cooks Springs quadrangle, in St. Clair and Shelby counties, and J. R. Ellis ran 142 miles of primary traverse and set 15 permanent marks for the control of the Cooks Springs and Weogufka quadrangles, in Coosa, Shelby, and Talladega counties.

*Georgia.*—The resurvey of the Talking Rock quadrangle, in Gilmer, Gordon, Murray, and Pickens counties, was commenced by Albert Pike, A. M. Walker, E. I. Ireland, and K. W. Trimble, the area mapped being 207 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area H. S. Senseney and K. W. Trimble ran 90 miles of primary levels and established 23 permanent bench marks.

*Maine.*—For the continuation of cooperative topographic surveys in Maine the State Water Storage Commission allotted \$4,900, which was met by the United States Geological Survey with an equal amount. The survey of the Waldoboro quadrangle, in Knox and Lincoln counties, was completed, and that of the Liberty quadrangle, in Kennebec, Knox, Lincoln, and Waldo counties, was commenced by W. H. Griffin, James McCormick, J. H. LeFeaver, and C. H. Davey, the total area mapped being 296 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Belfast quadrangle, in Knox and Waldo counties, K. E. Schlachter, J. M. Perkins, and Mr. Davey ran 137 miles of primary levels and established 39 permanent bench marks.

In addition to the cooperative work in Maine, the resurvey of the Portland and Casco Bay quadrangles, in Cumberland and York counties, was commenced by Hersey Munroe, J. H. Wheat, and R. C. Seitz, the area mapped being 60 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas Mr. Seitz ran 27 miles of primary levels and established 10 permanent bench marks.

*Mississippi.*—For the control of the Natchez and Vicksburg quadrangles, in Adams, Jefferson, Issaquena, and Warren counties, Miss., and Concordia and Madison parishes, La., J. R. Ellis ran 127 miles of primary traverse and set 13 permanent marks, this work being entirely in Mississippi.

*New Jersey.*—(See Pennsylvania, Milford quadrangle, p. 94.)

*New York.*—The State engineer and surveyor of New York allotted \$10,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted an equal amount. The survey of the Chateaugay, Gouverneur, and Lake Bonaparte quadrangles, in Clinton, Franklin, Jefferson, Lewis, and St. Lawrence counties, was completed, and that of the Canaseraga quadrangle, in Allegany and Livingston counties, was commenced by G. S. Smith, R. A. Kiger, J. M. Whitman, S. P. Floore, Roscoe Reeves, E. E. Witherspoon, W. H. S. Morey, R. C. McKinney, and A. J. Kavanagh, the total area mapped being 672 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Oswegatchie quad-



range, in Herkimer, Lewis, and St. Lawrence counties, G. T. Hawkins occupied 13 triangulation stations and permanently marked 8; S. S. Gannett and Mr. Kavanagh ran 58 miles of primary traverse and set 6 permanent marks; and Mr. Kavanagh ran 173 miles of primary levels and established 40 permanent bench marks. (See also Pennsylvania, Milford quadrangle, below.)

*North Carolina.*—The survey of the Belhaven and Kinston quadrangles, in Beaufort, Hyde, Washington, Greene, Lenoir, and Pitt counties, was completed, and that of the Gastonia quadrangle, in Gaston, Lincoln, and Mecklenberg counties, was commenced by G. S. Smith, J. M. Whitman, W. H. S. Morey, R. L. Harrison, R. A. Kiger, J. H. LeFeaver, J. B. Metcalfe, jr., and Roscoe Reeves, the total area mapped being 647 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Bunyon quadrangle, in Beaufort and Martin counties, G. T. Hawkins and C. W. Arnold ran 170 miles of primary traverse and set 20 permanent marks, and Mr. Metcalfe, Mr. Arnold, and R. H. Kilmer ran 165 miles of primary levels and established 31 permanent bench marks.

*Pennsylvania.*—The Topographic and Geologic Survey Commission of Pennsylvania expended \$6,816.55 for the continuation of the cooperative topographic survey of the State, and the United States Geological Survey expended a like sum. The survey of the Northeast and Somerset quadrangles, in Erie, Somerset, and Westmoreland counties, was completed, and that of the Windber quadrangle, in Bedford, Cambria, and Somerset counties, was begun by Oscar Jones, Robert Muldrow, J. F. McBeth, T. F. Slaughter, and E. E. Wither-spoon, the area mapped being 317 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. S. S. Gannett and G. T. Hawkins measured a base line on the Carnegie quadrangle, in Allegheny County, to check triangulation, occupying 5 triangulation stations and marking 4.

In addition to this work the survey of the Milford quadrangle, N. Y.-N. J.-Pa., in Sullivan (N. Y.), Sussex (N. J.), and Pike (Pa.) counties, was completed by Hersey Munroe, R. C. McKinney, W. O. Tufts, Olinus Smith, R. L. Harrison, W. H. S. Morey, J. M. Whitman, S. P. Floore, and Roscoe Reeves, the New York and Pennsylvania portions of this work being done in cooperation with the respective States. In mapping this quadrangle, 203 square miles of unmapped area was surveyed, 162 square miles in Pennsylvania and 41 square miles in New York, and 21 square miles in New Jersey was resurveyed, all for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area G. T. Hawkins and J. B. Metcalfe occupied 5 triangulation stations and marked 3, Mr. Hawkins ran 44 miles of primary traverse and set 2

permanent marks, and K. F. Maxcy ran 42 miles of primary levels and established 12 permanent bench marks.

In addition to the cooperative work in Pennsylvania the resurvey of the Reading quadrangle, in Berks County, was completed by Hershey Munroe, R. C. McKinney, and Olinus Smith, the area mapped being 214 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area Mr. Maxcy ran 12 miles of primary levels and established 4 permanent bench marks.

*Tennessee.*—The survey of the Murfreesboro quadrangle, in Rutherford and Wilson counties, was completed by J. F. McBeth, C. S. Wells, and T. F. Slaughter, the area mapped being 242 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area Mr. Wells ran 74 miles of primary levels and established 20 permanent bench marks.

*Vermont.*—For cooperative topographic surveys in Vermont the governor allotted \$2,000 and the United States Geological Survey allotted an equal amount. The survey of the Milton quadrangle was completed by C. E. Cooke, J. F. McBeth, and J. B. Metcalfe, jr., the area mapped being 213 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In connection with this work Mr. Metcalfe ran 70 miles of primary levels and established 14 permanent bench marks. The cooperative funds being insufficient to cover the completion of the work on the Milton quadrangle, the additional expenses were borne by the Federal Survey.

*Virginia.*—For the continuation of cooperative topographic surveys in Virginia the State geologist allotted \$4,250 and the United States Geological Survey allotted an equal amount. The resurvey of the Virginia portions of the Clintwood and Regina quadrangles, in Buchanan, Dickenson, and Wise counties, was completed, and the resurvey of the Bucu quadrangle, in Buchanan, Dickenson, and Russell counties, was commenced by J. I. Gayetty, C. W. Arnold, and F. W. Farnsworth, the area mapped being 381 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of these areas, H. S. Senseney ran 46 miles of primary levels and established 15 permanent bench marks.

In addition to the cooperative work in Virginia, the resurvey of the Eagle Rock quadrangle, in Alleghany, Botetourt, and Craig counties, was completed by T. F. Slaughter, the area mapped being 46 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of this area Mr. Senseney ran 33 miles of primary levels and established 9 permanent bench marks.

*West Virginia.*—In the continuation of cooperative topographic surveys in West Virginia the State geologist expended \$14,045 and

the United States Geological Survey \$11,705. A resurvey of areas previously mapped resulted in the completion of the survey of Hacker Valley, Pickens, and Summersville quadrangles, in Braxton, Clay, Nicholas, Randolph, Upshur, and Webster counties, and of the West Virginia portions of the Ingleside and Peterstown quadrangles, in Mercer, Monroe, and Summers counties, and of a part of the Winona quadrangle, in Fayette, Greenbrier, and Nicholas counties, the area mapped being 1,175 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. This work was done by E. I. Ireland, Fred McLaughlin, K. E. Schlachter, S. A. Judson, H. S. Senseney, M. A. Roudabush, C. S. Wells, and Kostka Mudd.

For the control of these areas, C. B. Kendall occupied 3 triangulation stations and Mr. Schlachter ran 109 miles of primary levels and established 28 permanent bench marks.

In addition to the cooperative work the State expended \$286.41, not met by Federal funds, on the resurvey of the portions of Berkeley and Jefferson counties for which maps on the scale of 1:62,500 were not already available. Preparatory to this work, G. T. Hawkins and J. B. Metcalfe, jr., ran 24 miles of primary traverse and established 3 permanent bench marks, this work falling in the Martinsburg quadrangle.

#### OFFICE WORK.

The drafting of the following sheets was completed: Washington and vicinity, D. C.-Md.-Va.; Waldoboro, Me.; Chateaugay, Gouverneur, and Lake Bonaparte, N. Y.; Milford, Pa.-N. Y.-N. J.; Northeast, Reading, and Somerset, Pa.; Milton, Vt.; Clintwood, Va.-Ky.; Eagle Rock and Fairfax, Va.; Hacker Valley, Pickens, and Summersville, W. Va.

Progress in the drafting of additional sheets was made as follows: Florence, Ala., 5 per cent; Canaseraga, N. Y., 31 per cent; Regina, Va.-Ky., 10 per cent; Bluefield, W. Va.-Va., 46 per cent; Peterstown, W. Va.-Va., 60 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Cooks Springs (Ala.), Talking Rock (Ga.), Liberty and Waldoboro (Me.), Chateaugay, Gouverneur, and Malone (N. Y.), Kinston (N. C.), Milford (Pa.-N. Y.-N. J.), Reading (Pa.), Milton (Vt.), Bucu, Clintwood, and Eagle Rock (Va.), Hacker Valley and Pickens (W. Va.) quadrangles.

Precise-level circuits were adjusted for the Flattop, Ingleside, and Peterstown (W. Va.) quadrangles.

Geographic positions were computed for the Cooks Springs (Ala.), Portland (Me.), Canaseraga, Hornell, Oswegatchie, and White

Lake (N. Y.), Belhaven, Bunyon, Jamesville, Kinston, and Plymouth (N. C.), Milford (Pa.-N. Y.-N. J.), Carnegie (Pa.), Hacker Valley, Ingleside, Peterstown, Pickens, Summersville, and Winona (W. Va.) quadrangles.

CENTRAL DIVISION.

FIELD WORK.

SUMMARY.

During the season topographic mapping was carried on in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, Virginia, and Wisconsin. This work comprised the completion of the survey of 20 quadrangles and 1 special area and of the resurvey of 4 quadrangles and 1 special area, and also of 1 special area which was partly surveyed and partly resurveyed, in addition to which 18 quadrangles were partly surveyed and 3 quadrangles were partly resurveyed. The total new area mapped was 5,362 square miles, for publication on the scale of 1:62,500; and the area resurveyed was 1,138 square miles, for publication on the scale of 1:62,500. In connection with this work 2,399 miles of primary levels were run and 580 permanent bench marks were established.

Primary traverse was carried on at different times by five parties, the work being distributed over portions of Illinois, Indiana, Iowa, Michigan, Minnesota, and Missouri. The total area covered by this primary control was about 4,588 square miles, 1,234 linear miles of primary traverse being run and 115 permanent marks set. The result of this work was to make control available in 74 quadrangles.

*Topographic surveys in central division from July 1, 1913, to June 30, 1914.*

State.	Contour interval.	For publication on scale of 1 : 62,500.		Total area surveyed.	Primary levels.		Primary traverse.	
		New.	Resurvey.		Distance run.	Bench marks.	Distance run.	Permanent marks.
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>	
Illinois.....	20	884	232	1,116	392	106	184	13
Indiana.....	20	209	.....	209	56	12	41	2
Iowa.....	20	162	.....	162	156	42	40	7
Kentucky.....	10, 20, 50	319	710	1,029	261	74	.....	.....
Michigan.....	5, 20	154	.....	154	334	74	129	10
Minnesota.....	10	515	.....	515	32	8	20	.....
Missouri.....	20	502	193	695	252	84	820	83
Ohio.....	10, 20	2,473	.....	2,473	861	173	.....	.....
Virginia.....	50	.....	3	3	.....	.....	.....	.....
Wisconsin.....	20	144	.....	144	55	7	.....	.....
	.....	5,362	1,138	6,500	2,399	580	1,234	115

## DETAILS OF WORK BY STATES.

*Illinois.*—The governor of Illinois allotted \$10,000 for the continuation of cooperative topographic surveys in Illinois and an additional \$1,500 from a fund advanced by private persons for the mapping of the Gallatin County portions of the Equality and Shawneetown quadrangles, and the United States Geological Survey allotted \$11,500 to meet these amounts. The survey of the Mount Olive and Avon quadrangles and the Illinois portion of the Edgington quadrangle, in Macoupin, Montgomery, Fulton, Knox, McDonough, Warren, Mercer, and Rock Island counties, was completed, and that of the Sparta quadrangle, in Perry, Randolph, St. Clair, and Washington counties, was commenced by Frank Tweedy, W. L. Miller, Fred Graff, jr., Gilbert Young, L. L. Lee, and W. S. Gehres, the area mapped being 794 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The survey of the Iowa portion of the Edgington quadrangle, in Muscatine and Scott counties, was completed by Frank Tweedy, the area mapped being 52 square miles, for publication on the same scale as the Illinois portion, all expenses being borne by the Federal Survey. The mapping of the Equality quadrangle and of the Illinois portion of the Shawneetown quadrangle was continued by O. H. Nelson, E. L. Hain, J. A. Duck, and F. B. Barrett, the area mapped being 90 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The resurvey of the Marseilles quadrangle, in Grundy, Kendall, and La Salle counties, was completed, and that of the Morris quadrangle, in Grundy and Kendall counties, was commenced by L. L. Lee, the area mapped being 232 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas and of the Brownfield quadrangle, in Johnson, Massac, and Pope counties, W. S. Gehres, C. R. French, G. W. Lucas, R. G. Clinite, and S. R. Archer ran 413 miles of primary levels and established 111 permanent bench marks, 21 miles of levels and 5 bench marks being in Iowa. For the control of the Birds, Equality, Brownfield, Marion, Stonefort, Vienna, Merom, Oaktown, and Vincennes (Ill.-Ind.) quadrangles and the Illinois portion of the Golconda and Paducah quadrangles, in Crawford, Lawrence, Gallatin, Pope, Hardin, Saline, Johnson, Massac, Williamson, Pulaski, and Clark counties, Ill., and Knox and Sullivan counties, Ind., C. B. Kendall ran 217 miles of primary traverse and set 15 permanent marks, 33 miles and 2 marks being in Indiana.

*Indiana.*—The mapping of the Indiana portion of the Vincennes quadrangle, in Knox County, was completed by C. L. Sadler and Charles Hartmann, jr., the area mapped being 97 square miles, for publication on the scale of 1:62,500, with a contour interval of 20

feet. For the control of this area S. L. Parker ran 30 miles of primary levels and established 6 permanent bench marks. (See also pp. 98 and 100.)

*Iowa.*—The State geologist allotted \$1,750 for the continuation of cooperative topographic surveys in Iowa, and the Federal Survey allotted an equal amount. The survey of the Boone quadrangle, in Boone, Hamilton, and Webster counties, was continued by W. L. Miller, the area mapped being 110 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Attica, Chariton, and New Virginia quadrangles, in Lucas, Marion, Munroe, Warren, and Clarke counties, C. B. Kendall ran 40 miles of primary traverse and set 7 permanent marks, and R. G. Clinite ran 135 miles of primary levels and established 37 permanent marks. (See also p. 98.)

*Kentucky.*—The Kentucky Geological Survey allotted \$10,000 for the continuation of cooperative topographic surveys in Kentucky and the Federal Survey allotted an equal amount. The survey of the Kentucky portions of the Evansville and Shawneetown quadrangles, in Crittenden, Union, and Henderson counties, was completed, and that of the Alzey quadrangle, in Henderson and Union counties, was commenced by C. W. Goodlove, C. P. McKinley, J. H. Wilson, R. M. Herrington, and W. S. Gehres, the area mapped being 319 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. The survey of the Indiana portion of the Alzey quadrangle, in Posey County, was commenced by C. W. Goodlove, R. M. Herrington, and W. S. Gehres, the area mapped being 112 square miles, for publication on the same scale as the Kentucky portion. All expenses of work in the Indiana area were borne entirely from Federal funds. The resurvey of the Cornettsville, Ovenfork, and Virgie quadrangles, in Floyd, Harlan, Knott, Leslie, Letcher, Pike, and Perry counties, was completed, and that of the Laynesville quadrangle, in Floyd, Johnson, Martin, and Pike counties, was commenced by J. R. Eakin, C. P. McKinley, J. M. Rawls, N. E. Ballmer, W. A. Reiter, H. E. Burney, S. A. Judson, Howard Clark, L. A. Darrah, and J. T. Graves, the area mapped being 713 square miles, for publication on the scale of 1:62,500, with a 50-foot contour interval. An area of 3 square miles in the Ovenfork quadrangle falling in Wise County, Va., is included in the total area above given. For the control of the Cornettsville, Laynesville, Virgie, Inez, and Alzey quadrangles and the Kentucky portion of the Evansville quadrangles, in Harlan, Knott, Leslie, Letcher, Perry, Floyd, and Pike counties, S. R. Archer and E. C. Bibbee ran 275 miles of primary levels and established 76 permanent bench marks, 14 miles and 2 marks being in Indiana.



*Michigan.*—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted \$2,500, which was met by the United States Geological Survey with an equal amount. The survey of the St. Charles quadrangle and of the Michigan portion of the Centerville quadrangle, in Midland, Saginaw, and St. Joseph counties, was commenced by C. L. Sadler, L. L. Lee, and H. E. Burney, the area mapped being 154 square miles, for publication on the scale of 1:62,500, with contour intervals of 5 and 20 feet. For the control of these areas and of the Chesaning, Corunna, Burt, Durand, and Schoolcraft quadrangles and the Michigan portion of the Centerville, Sturgis, and Shipshewanna quadrangles, in Midland, Saginaw, Shiawassee, Ingham, Livingston, Genesee, and St. Joseph counties, Mich., and Elkhart, Lagrange, and Noble counties, Ind., J. H. Wilson ran 137 miles of primary traverse (8 miles in Indiana) and established 10 permanent marks. For the control of the Coldwater, Reading, St. Charles, Chesaning, Corunna, Saginaw, Schoolcraft, Kalamazoo, Wayland, Sturgis, and Centerville (Mich.-Ind.) quadrangles, in Midland, Saginaw, Shiawassee, Ingham, Livingston, Bay, St. Joseph, Kalamazoo, Branch, Hillsdale, Allegan, and Kent counties, Mich., and Elkhart and Lagrange counties, Ind., R. G. Clinite and E. C. Bibbee ran 346 miles of primary levels and established 78 permanent bench marks, 12 miles of levels and 4 bench marks being in Indiana. (See also pp. 98 and 99.)

*Minnesota.*—The State drainage engineer of Minnesota allotted \$10,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey made an equal allotment. The survey of the Emily quadrangle, in Aitkin and Crow Wing counties, was completed, and that of the Aitkin and Pelican Rapids quadrangles, in Aitkin, Becker, Clay, and Ottertail counties, was commenced by A. M. Walker, E. L. Hain, F. B. Barrett, J. H. Wilson, and L. B. Roberts, the total area mapped being 515 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. For the control of the Emily quadrangle, J. H. Wilson ran 20 miles of primary traverse.

In addition to the cooperative work in Minnesota, a special drainage survey of the diminished Red Lake Indian Reservation was made by A. P. Meade for the Office of Indian Affairs, the funds for this work having been allotted from the unexpended balance remaining from the appropriation for the survey of the ceded Chippewa lands. The area covered by this survey was 943 square miles. In connection with this work, Mr. Meade ran 32 miles of primary levels and established 8 permanent bench marks. The funds expended on this work amounted to \$3,320.11.

*Missouri.*—The State geologist of Missouri allotted \$7,500 for the continuation of the cooperative topographic survey of that State, and



the United States Geological Survey allotted an equal amount. A further allotment of \$2,500 was made by the State for the completion of the map of Platte County, on the scale of 1:62,500, with a contour interval of 20 feet. In connection with this county map J. G. Staack, J. A. Duck, O. H. Nelson, and F. B. Barrett surveyed 48 square miles and resurveyed 59 square miles, covering portions of the Armourdale, Dearborn, Sugar Lake, Gower, and Waldron quadrangles. The survey of the Missouri portion of the Crystal City quadrangle, in Jefferson, Ste. Genevieve, and St. Francois counties, was completed by F. W. Hughes and W. F. Hicks, the area mapped being 207 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area and of the Cuba, Eminence, Sinkin, Stone Hill, Salem, and Steelville quadrangles, in Crawford, Dent, Franklin, Reynolds, Shannon, and Gasconade counties, E. C. Bibbee and G. W. Lucas ran 153 miles of primary levels and established 45 permanent bench marks. To complete the survey of Ste. Genevieve County on the scale of 1:62,500, with a contour interval of 20 feet, F. W. Hughes mapped 3 square miles in the Knob Lick quadrangle. The resurvey of the Sturgeon quadrangle, in Audrain, Boone, Howard, and Randolph counties, was continued by C. G. Anderson and W. L. Miller, the area mapped being 134 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Chillicothe, Gallatin, Gillman City, Gower, Maysville, Plattsburg, Polo, Trenton, Winston, Boynton, Braymer, Chula, Dawn, Galt, Lucerne, Milan, Celt, Fordland, Lebanon, Long Lane, Niangua, Passover, Sleeper, Exchange, Bandyville, Montier, Corridon, Willow Springs, Ruble, Cedar Gap, Redford, Cabool, Macomb, and Eminence 15-minute quadrangles and the Sedalia, Harrisonville, Lexington, and Warrensburg 30-minute quadrangles, in Grundy, Livingston, Caldwell, Daviess, Harrison, Buchanan, Clinton, Platte, Ray, Dekalb, Putnam, Sullivan, Carroll, Linn, Mercer, Camden, Dallas, Christian, Douglas, Webster, Laclede, Miller, Morgan, Carter, Reynolds, Shannon, Oregon, Howell, Wright, Texas, Cass, Jackson, Johnson, Lafayette, Henry, and Pettis counties, E. L. McNair ran 820 miles of primary traverse and set 83 permanent marks.

In addition to the cooperative work, the mapping of the Missouri portion of the Chester quadrangle, in Perry and Ste. Genevieve counties, was completed, and that of the Missouri portion of the Kimmswick quadrangle, in Jefferson and St. Louis counties, was commenced by F. W. Hughes, E. L. Hain, O. H. Nelson, F. B. Barrett, G. W. Lucas, W. F. Hicks, and R. H. Randall, the area mapped being 244 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas G. W. Lucas ran 99 miles of primary levels and established 39 permanent bench marks.

*Ohio.*—The governor of Ohio allotted \$25,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted \$10,000. The survey of the Alger, Bellefontaine, Brinkhaven, Bucyrus, East Liberty, Larue, Kenton, Mount Gilead, Norwalk, Richwood, Shauck, and Waynesville quadrangles and of the Ohio portion of the Greenup quadrangle, in Allen, Auglaize, Hardin, Logan, Champaign, Holmes, Knox, Coshocton, Crawford, Huron, Seneca, Union, Lawrence, Scioto, Marion, Wyandot, Morrow, Clark, Richland, Greene, Warren, and Montgomery counties, was completed, and that of the Greenfield, Mechanicsburg, and St. Paris quadrangles, in Fayette, Highland, Ross, Champaign, Clark, Logan, Madison, and Union counties, was commenced, the total area mapped being 2,473 square miles, for publication on the scale of 1:62,500, with contour intervals of 10 and 20 feet. This work was done by J. H. Jennings, C. W. Goodlove, Fred Graff, jr., Merrill Hackett, A. B. Searle, Gilbert Young, J. A. Duck, N. E. Ballmer, R. M. Herrington, W. S. Gehres, M. A. Roudabush, G. R. Logue, C. R. French, and H. E. Burney.

For the control of these areas and of the Octa and Xenia quadrangles, in Clinton, Greene, and Warren counties, E. C. Bibbee, C. E. Mills, S. L. Parker, R. G. Clinite, and F. L. Whaley ran 861 miles of primary levels and established 173 permanent bench marks.

*Wisconsin.*—The survey of the Rapp quadrangle, in Monroe County, was commenced by R. T. Evans, O. H. Nelson, J. M. Perkins, and D. H. Watson, the area mapped being 144 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of this area J. M. Perkins ran 55 miles of primary levels and established 7 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Avon, Marseilles, and Mount Olive, Ill.; Edgington, Ill.-Iowa; Vincennes, Ill.-Ind.; Cornettsville, Ky.; Ovenfork, Ky.-Va.; Cuyuna, Minn.; Platte County, Mo.; Chester, Crystal City, and Renault, Mo.-Ill.; Alger, Bellefontaine, Brinkhaven, Bucyrus, Coshocton, Crestline, East Liberty, Kenton, Larue, Millersburg, Mount Gilead, Norwalk, Richwood, Shauck, Siam, and Waynesville, Ohio.

Progress in the drafting of additional sheets was made as follows: Equality, Ill., 52 per cent; Boone, Iowa, 80 per cent; Shawneetown, Ky.-Ill., 73 per cent; Pelican Rapids, Minn., 29 per cent; diminished Red Lake Reservation, Minn., 90 per cent; Greenup, Ohio, 34 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Avon, Equality, and Marseilles (Ill.), Shipshewanna (Ind.-Mich.), Attica and Chariton

(Iowa), Alzey, Cornettsville, Evansville, Laynesville, Ovenfork, and Virgie (Ky.), Chesaning, Coldwater, Corunna, Kalamazoo, Reading, St. Charles, Schoolcraft, and Wayland (Mich.), Centerville and Sturgis (Mich.-Ind.), Chester, Crystal City, Kimmswick, and Renault (Mo.), Alger, Bellefontaine, East Liberty, Greenville, Kenton, Mechanicsburg, Milford Center, Octa, Richwood, St. Paris, Waynesville, and Xenia (Ohio) quadrangles.

Geographic positions were computed for the Birds, Brownfield, Equality, Fords Ferry, Golconda, Stonefort, Vienna, and Vincennes (Ill.), Merom (Ind.-Ill.), Oaktown and Vincennes (Ind.), Shippshewanna (Ind.-Mich.), Attica and Chariton (Iowa), Burt, Chesaning, Corunna, Dewitt, Durand, Elsie, Freeland, Ithaca, Jones, Merrill, Muir, Perrinton, Saginaw, St. Charles, and Schoolcraft (Mich.), Centerville and Sturgis (Mich.-Ind.), Aitkin (Minn.), Bandyville, Boynton, Braymer, Cabool, Cedar Gap, Celt, Chillicothe, Chula, Clear Springs, Corridon, Dawn, Eminence, Exchange, Fordland, Gallatin, Galt, Gower, Lebanon, Long Lane, Low Wossie, Lucerne, Maysville, Macomb, Milan, Montier, Neosho, Niangua, Passover, Plattsburg, Polo, Redford, Ritchey, Ruble, Sleeper, Trenton, Willow Springs, and Winston (Mo.) quadrangles.

#### ROCKY MOUNTAIN DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Colorado, Montana, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. This work comprised the completion of the survey of 11 quadrangles, in addition to which 5 quadrangles were partly surveyed. The total new area mapped was 3,781 square miles, 2,548 for publication on the scale of 1:125,000, 1,229 square miles for publication on the scale of 1:62,500, and 4 square miles for publication on the scale of 1:31,680. In addition, the map of 1 quadrangle was revised and those of 2 quadrangles were partly revised, the area covered being 1,105 square miles. In connection with this work 474 miles of primary levels were run and 160 permanent bench marks were established. A profile survey was made of a portion of one stream, covering a distance of 228 linear miles.

Primary traverse and primary triangulation were carried on at different times by four parties, the work extending over portions of Colorado, Montana, New Mexico, and Oklahoma. The total area covered by this primary control was about 4,120 square miles, of which 240 was controlled by primary traverse, 73 miles being run and 3 permanent marks set. Twenty-three triangulation stations

were occupied and 24 marked. The result of this work was to make control available in 8 quadrangles.

*Topographic surveys in Rocky Mountain division from July 1, 1913, to June 30, 1914.*

State.	Con- tour inter- val.	For publication on scale of—			Total area sur- veyed.	Primary levels.		Primary traverse.		Triangulation.	
		1 : 125,000	1 : 62,500	1 : 31,680		Dis- tance run.	Bench marks.	Dis- tance run.	Per- ma- nent marks.	Sta- tions occu- pied.	Stations marked.
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>			
Colorado.....	100	2,118	.....	.....	2,118	213	77	.....	.....	15	18
Montana.....	5, 20, 100	430	199	4	633	45	15	.....	.....	.....	.....
Nebraska.....	20	.....	213	.....	213	.....	.....	.....	.....	.....	.....
New Mexico.....	50	.....	82	.....	82	.....	.....	.....	.....	8	6
Oklahoma.....	25	.....	156	.....	156	50	25	73	3	.....	.....
Texas.....	5	.....	296	.....	296	114	31	.....	.....	.....	.....
Wyoming.....	25	.....	283	.....	283	52	12	.....	.....	.....	.....
		2,548	1,229	4	3,781	474	160	73	3	23	24

DETAILS OF WORK BY STATES.

*Colorado.*—The survey of the Longs Peak and Chromo quadrangles, lying partly in the Arapahoe, Colorado, Rio Grande, and San Juan national forests, in Boulder, Grand, Larimer, Archuleta, Conejos, Mineral, and Rio Grande counties, was completed by B. A. Jenkins, S. T. Penick, C. A. Ecklund, C. C. Holder, and R. R. Monbeck, the total area mapped being 792 square miles, of which 634 square miles is in the national forest, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Longs Peak quadrangle and of the Mount Powell, Kremmling, James Peak, Eagle, and Glenwood Springs quadrangles, partly in the Arapahoe, Holy Cross, Leadville, Pike, and White River national forests, in Eagle, Grand, Summit, Jackson, Boulder, Gilpin, Clear Creek, Routt, and Park counties, C. F. Urquhart and C. B. Kendall occupied 15 triangulation stations and permanently marked 18. The survey of the Creede quadrangle, in the Cochetopa, Rio Grande, and San Juan national forests, in Mineral, Rio Grande, and Saguache counties, was continued, and that of the Lay quadrangle, in Moffat County, was begun, by J. H. Wilke, Basil Duke, Mr. Penick, L. B. Glasgow, Mr. Holder, and Mr. Rowell, the area mapped being 1,326 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, 831 square miles being in the national forests. For the control of these areas and of the Home, Montrose, Naturita, and Coventry quadrangles, lying partly in the Arapahoe, Colorado, La Sal, Gunnison, Montezuma, and Uncompahgre national forests, in Jackson, Larimer, Montrose, and

San Miguel counties, Mr. Ecklund, Mr. Rowell, and H. B. Edwards ran 213 miles of primary levels and established 77 permanent bench marks.

*Montana.*—The survey of the Stryker quadrangle, lying partly in the Blackfeet National Forest, in Flathead and Lincoln counties, was completed by R. T. Evans, Gilbert Young, C. P. McKinley, and F. L. Whaley, the total area mapped being 430 square miles, of which 347 square miles is in the national forest, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of this area Mr. Whaley ran 45 miles of primary levels and established 15 permanent bench marks. The survey of the portions of the Wolf Point, Oswego, and Frazer quadrangles, lying south of Missouri River, in Dawson, Valley, and Sheridan counties, was completed, and that of the portion of the Nashua quadrangle, lying south of Missouri River, in Dawson and Valley counties, was begun, the area mapped being 199 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The portions of these quadrangles lying north of Missouri River were mapped by the General Land Office.

A profile survey of Missouri River was made by R. H. Reineck, the distance traversed being 228 linear miles, in Broadwater, Cascade, and Lewis and Clark counties. In connection with this work a reservoir site covering 4 square miles was surveyed, for publication on the scale of 1:31,680, with a contour interval of 5 feet. (See also p. 108.)

*Nebraska.*—The board of regents of the University of Nebraska allotted \$2,000 for the continuation of the cooperative topographic surveys in that State, and the United States Geological Survey allotted an equal amount. The survey of the Howe quadrangle, in Nemaha and Richardson counties, was completed by R. H. Reineck, S. T. Penick, and R. R. Monbeck, the area mapped being 213 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

*New Mexico.*—The survey of the Brilliant quadrangle, in Colfax County, was completed by E. P. Davis, C. A. Ecklund, and C. C. Holder, the total area mapped being 82 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Reserve quadrangle, in Socorro County, C. B. Kendall and Mr. Holder occupied 8 triangulation stations and permanently marked 6.

*Oklahoma.*—The director of the Oklahoma Geological Survey allotted \$1,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted an equal amount. The survey of the Foraker quadrangle, in Osage

County, was commenced by S. T. Penick and R. R. Monbeck, the area mapped being 156 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of this quadrangle E. L. McNair ran 73 miles of primary traverse and set 3 permanent marks, and Mr. Monbeck and R. W. Burchard ran 50 miles of primary levels and established 25 permanent bench marks.

In addition to the cooperative work in Oklahoma, the revision of the map of the Claremore quadrangle, in Rogers, Tulsa, Wagoner, and Washington counties, was completed, and that of the Hominy quadrangle, in Osage, Pawnee, and Tulsa counties, was commenced by R. W. Berry, the area covered by this revision being 981 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet.

A secondary level line was run in the Cushing oil field by Mr. Berry to establish elevations desired by the Bureau of Mines, which bore all expenses of this work.

*South Dakota.*—The revision of the portions of the maps of Sturgis and Spearfish quadrangles, in Lawrence and Meade counties, covering mining districts, was completed by R. W. Berry, the area revised being 124 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet.

*Texas.*—The survey of the Texas portion of the Mission and San Juan quadrangles, in Hidalgo County, was completed by E. P. Davis, R. C. Seitz, and C. A. Ecklund, the area mapped being 296 square miles, for publication on the scale of 1:62,500, with a contour interval of 5 feet. For the control of these areas Mr. Seitz ran 114 miles of primary levels and established 31 permanent bench marks.

*Wyoming.*—The survey of the Ilo quadrangle, in Hot Springs County, was completed, and that of the northwest quarter of the Thermopolis quadrangle, in Hot Springs and Washakie counties, was begun by C. C. Gardner, R. H. Reineck, G. M. Ruby, and C. R. Fisher, the total area mapped being 283 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas Mr. Fisher ran 52 miles of primary levels and established 12 permanent bench marks. (See also pp. 108 and 110.)

#### OFFICE WORK.

The drafting of the following sheets was completed: Chromo and Longs Peak, Colo.; Frazer, Missouri River, Oswego, Stryker, and Wolf Point, Mont.; Falls City and Howe, Nebr.; Brilliant, N. Mex.; Spearfish and Sturgis (revision), S. Dak.; Ilo, Wyo.

The Cuskers, Spring Creek, Todd Lakes, and Tule Valley 15' maps in Montana, surveys for which were made by the General Land Office, were adjusted, assembled, and photolithographed by the topographic branch.



Progress in the drafting of additional sheets was made as follows: Creede, Colo., 83 per cent; Lay, Colo., 46 per cent; Nashua, Mont., 90 per cent; Mission, Tex., 30 per cent; San Juan, Tex., 75 per cent; Thermopolis, Wyo., 5 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Chromo, Creede, Del Norte, Elkhead, Lay, Longs Peak, and San Cristobal (Colo.), Marston (Mont.), Brownsville, Mission, Point Isabel, and San Juan (Tex.), and Ilo (Wyo.) quadrangles.

Geographic positions were computed for the Kremmling, Longs Peak, and Mount Powell (Colo.), Hamilton (Mont.), Canyon Largo, Mogollon, and Reserve (N. Mex.), Foraker (Okla.), and Mission, Clarksville, and San Juan (Tex.) quadrangles.

#### NORTHWESTERN DIVISION.

##### FIELD WORK.

##### SUMMARY.

During the season topographic mapping was carried on in Idaho (with small areas extending into Montana and Wyoming), Oregon, and Washington. This work comprised the completion of the survey of 6 quadrangles and of 2 special areas and the partial survey of 12 quadrangles. The total new area mapped was 3,295 square miles, 136 square miles for publication on the scale of 1:31,680, 675 square miles for publication on the scale of 1:62,500, 1,812 square miles for publication on the scale of 1:125,000, and 672 square miles for publication on the scale of 1:250,000. In connection with this work 722 miles of primary and precise levels were run and 203 permanent bench marks were established. In addition, profile surveys were made of portions of 10 rivers, the distance traversed being 449 linear miles, in connection with which 4 square miles was surveyed for publication on the scale of 1:31,680.

Primary triangulation and primary traverse were carried on at different times by three parties in portions of Idaho, Montana, Oregon, and Washington. The total area covered by this primary control was about 7,787 square miles, of which about 1,042 square miles was controlled by primary traverse, 384 miles being run and 96 permanent marks set. Forty-four triangulation stations were occupied and 56 permanently marked. The result of this work was to make control available in 23 quadrangles.



*Topographic surveys in northwestern division from July 1, 1913, to June 30, 1914.*

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#### DETAILS OF WORK BY STATES.

*Idaho.*—The survey of T. 2 N., R. 45 E., T. 3 N., R. 44 E., and T. 4 N., Rs. 44 and 45 E., in Bingham and Fremont counties, was commenced by J. L. Lewis and C. G. Anderson, the area mapped being 47 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. The survey of the Fort Hall Indian Reservation, in Bannock, Bingham, and Oneida counties, was completed by C. G. Anderson, the area mapped being 672 square miles, for publication on the scale of 1:250,000, with a contour interval of 100 feet. A profile survey of Bear River was made by Albert Pike, covering 86 miles of the river, from Riverdale to Novene, in Bannock and Oneida counties, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet. For the control of the Mink Creek quadrangle, in Bannock, Bear Lake, and Franklin counties, Howard Clark ran 10 miles of primary levels and established 2 permanent bench marks.

*Idaho-Montana.*—The survey of the Taft quadrangle, in the Lolo, Cabinet, St. Joe, and Coeur d'Alene national forests, in Shoshone County, Idaho, and Missoula and Sanders counties, Mont., was continued by J. E. Blackburn, the area mapped being 208 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 200 square miles lies in Idaho and 8 in Montana, and 200 square miles is in the national forests. For the control of the Salmon, Fishtrap, Polaris, Gibbons Pass, Trappers Peak, Noble, Watchtower Peak, Vinegar Hill, Hamilton, and Sapphire quadrangles, in Lemhi and Idaho counties, Idaho, and Beaverhead, Deer Lodge, Granite, and Ravalli counties, Mont., T. M. Bannon occupied 27 triangulation stations and marked 40, of which 15 stations were occupied and 33 marked in Idaho.

*Idaho-Wyoming.*—The mapping of the Freedom quadrangle, in the Caribou National Forest, in Bannock County, Idaho, and Lin-

coln County, Wyo., was completed by J. L. Lewis, the area mapped being 143 square miles, for publication on the scale of 1:62,500, with a contour interval of 50 feet. Of this area 117 square miles lies in Idaho and 26 square miles in Wyoming.

*Oregon.*—The State engineer of Oregon allotted \$18,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Willamette Valley was continued and included the completion of the mapping of the Albany quadrangle and the continuation of the mapping of the Salem and Corvallis quadrangles, in Benton, Linn, Marion, and Polk counties, the total area mapped being 132 square miles, for publication on the scale of 1:31,680, with a contour interval of 5 feet. This work was done by J. H. Wheat, Charles Hartmann, jr., W. S. S. Johnson, Frederick Rider, W. R. Chenoweth, and W. G. Carson. The mapping of the Reedville quadrangle, in Clackamas, Yamhill, and Washington counties, was commenced by C. H. Birdseye, the area mapped being 22 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas and of the Aumsville, Dallas, Mount Angel, and McCoy quadrangles, in Clackamas, Linn, Marion, Polk, and Yamhill counties, L. F. Biggs ran 352 miles of primary traverse and set 91 permanent marks, and Mr. Biggs and D. S. Birkett ran 327 miles of primary levels and established 83 permanent bench marks. The mapping of the Oregon portion of the Arlington quadrangle, in Gilliam and Sherman counties, and that of the Condon quadrangle, in Gilliam, Morrow, Sherman, and Wheeler counties, was commenced by C. H. Birdseye, C. L. Sadler, O. G. Taylor, and S. E. Taylor, the area mapped being 227 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of the Condon, Heppner, Spray, Paulina, Round Mountain, and Twickenham quadrangles, in Gilliam, Morrow, Sherman, Wheeler, Grant, Crook, and Wasco counties, J. R. Ellis occupied 17 and marked 16 triangulation stations, and for the control of the Condon quadrangle D. S. Birkett ran 123 miles of primary levels and established 38 permanent bench marks. Profile surveys of Willamette, Santiam, Clackamas, Sandy, and Hood rivers were made by S. G. Lunde, Charles Hartmann, jr., R. L. Harrison, and W. R. Chenoweth, the distance traversed being 250 linear miles in Clackamas, Lane, Marion, Linn, and Wasco counties. Of this distance 190 miles lies in the Oregon, Cascade, Santiam, and Umpqua national forests.

In addition to the cooperative work in Oregon, the mapping of the Cazadero quadrangle, in the Oregon National Forest, in Clackamas and Multnomah counties, was completed, and that of the Diamond Lake quadrangle, in the Umpqua, Crater, and Paulina national

forests, in Douglas, Lane, and Klamath counties, was continued by J. G. Staack and O. H. Nelson, the area mapped being 512 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Diamond Lake quadrangle Mr. Nelson ran 16 miles of primary levels and established 5 permanent bench marks.

*Washington.*—The Board of Geological Survey of Washington allotted \$12,500 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Arlington, Ocosta, and Wenatchee quadrangles, in Klickitat, Chehalis, and Chelan counties, was completed by A. E. Murlin, H. L. McDonald, Charles Hartmann, jr., F. W. Crisp, and Frederick Rider, and that of the Chehalis, Haven, and Mitchell quadrangles, in Lewis, Thurston, Benton, Kittitas, Yakima, and Grant counties, was continued, the total area mapped being 870 square miles, 605 square miles for publication on the scale of 1:125,000, with a contour interval of 50 feet, and 265 square miles for publication on the scale of 1:62,500, with contour intervals of 25 and 50 feet. For the control of the Ocosta quadrangle L. F. Biggs ran 32 miles of primary traverse and set 5 permanent marks, and for the control of the Arlington and Tacoma quadrangles, the latter of which had been previously mapped, D. S. Birkett ran 97 miles of primary and precise levels and established 23 permanent bench marks. Profile surveys were made by A. J. Ogle of portions of Snoqualmie, Skykomish, Stilaguamish, and Sultan rivers, the distance traversed being 113 linear miles in King and Snohomish counties. In connection with this work reservoir sites covering 4 square miles were surveyed, for publication on the scale of 1:31,680, with contour intervals of 5 and 25 feet.

In addition to the cooperative work in Washington, the survey of the Mount Rainier National Park, in Pierce and Lewis counties, was completed by C. H. Birdseye, W. O. Tufts, O. G. Taylor, and S. E. Taylor, the area mapped being 198 square miles, for publication on the scale of 1:62,500, with a contour interval of 100 feet. Of this area 62 square miles lies outside of the park, in the Mount Rainier quadrangle. The mapping of the Mount St. Helens quadrangle, in the Columbia National Forest, in Clarke, Cowlitz, Lewis, and Skamania counties, was continued by Albert Pike and W. R. Chenoweth, the area mapped being 260 square miles, of which 150 square miles is in the national forest, for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of these areas and of the Eatonville quadrangle, in Lewis and Pierce counties, E. M. Bandli ran 149 miles of primary levels and established 52 permanent bench marks.

## OFFICE WORK.

The drafting of the following sheets was completed: Bear River and Fort Hall Indian Reservation, Idaho; Freedom, Idaho-Wyo.; Albany, Cazadero, Clackamas River, Hood River, Sandy River, Santiam River, and Willamette River, Oreg.; Arlington, Oreg.-Wash.; Hoquiam, Mount Rainier National Park, Ocosta, Sanpoil River, Skykomish River, Snoqualmie River, Sultan River, and Wenatchee, Wash.

Progress in the drafting of additional sheets was made as follows: Victor, Idaho, 6 per cent; Taft, Idaho-Mont., 83 per cent; Condon, Oreg., 22 per cent; Corvallis, Oreg., 22 per cent; Diamond Lake, Oreg., 38 per cent; Salem, Oreg., 17 per cent; Chehalis, Wash., 40 per cent; Haven, Wash., 37 per cent; Mitchell, Wash., 37 per cent; Mount Rainier, Wash., 7 per cent; Mount St. Helens, Wash., 37 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Arlington, Blalock Island, Castlerock, Eatonville, Fordnah, Haven, Kalama, Mount St. Helens, and Mount Rainier (Wash.), Arlington, Aumsville, Condon, Dallas, Mount Angel, Reedville, and Salem (Oreg.) quadrangles.

Geographic positions were computed for the Cape Elizabeth, Hoquiam, Humptulips, and Ocosta (Wash.), Condon, Crook, Heppner, Independence, Paulina, Rickreall, Round Mountain, Salem, Spray, and Sydney (Oreg.), Dickey, Gibbons Pass, Hamilton, Junction, May, Nicholia, Noble, Polaris, Salmon, Sapphire, Trappers Peak, Watchtower Peak, and Vinegar Hill (Idaho-Mont.) quadrangles.

## PACIFIC DIVISION.

## FIELD WORK.

## SUMMARY.

During the season topographic mapping was carried on in Arizona, California, Nevada, and Utah. This work comprised the completion of the survey of 13 quadrangles, the partial survey of 9 quadrangles, the partial resurvey of 3 quadrangles and 1 special area, and the partial revision of the map of 1 special area. The total new area mapped was 3,741 square miles—2,979 square miles for publication on the scale of 1:125,000, 153 square miles for publication on the scale of 1:62,500, and 609 square miles for publication on the scale of 1:31,680. The area resurveyed was 1,048 square miles—745 square miles for publication on the scale of 1:125,000, 245 square miles for publication on the scale of 1:62,500, and 58 square miles for publication on the scale of 1:24,000. In connection with this work 724 miles of primary and precise levels were run, and 124 permanent bench

marks were established. In addition, profile surveys were made of three rivers, the distance traversed being 114 linear miles.

Primary triangulation was carried on at different times by 5 parties, the work being distributed over portions of California, Nevada, and Utah. The total area covered by this primary control was about 2,500 square miles, 41 triangulation stations being occupied and 28 permanently marked. The result of this work was to make control available in 11 quadrangles.

Topographic surveys were made in the Territory of Hawaii covering portions of one island (Hawaii). The survey of two 15-minute quadrangles was completed and that of one 15-minute quadrangle was continued, the total area mapped being 342 square miles, for publication on the scale of 1:31,680, in connection with which 44 miles of primary levels were run and 7 permanent bench marks were established. Primary triangulation and primary traverse were also carried on, 43 miles of primary traverse being run, and 4 triangulation stations were occupied and 1 marked.

*Topographic surveys in Pacific division from July 1, 1913, to June 30, 1914.*

1914

1914

#### DETAILS OF WORK BY STATES.

*Arizona.*—The survey of the Pearce quadrangle, lying partly in the Chiricahua National Forest, in Cochise County, was completed, and that of the San Simon quadrangle, also partly in the Chiricahua National Forest, in Cochise, Graham, and Greenlee counties, Ariz., and Grant County, N. Mex., was commenced by S. E. Taylor and Cornelius Schnurr, the area mapped being 1,304 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, 55 square miles being within the national forest. For the control of these areas Mr. Schnurr ran 111 miles of primary levels and established 26 permanent marks. All the work in the San Simon quadrangle was in the Arizona portion.

*California.*—The department of engineering of California allotted \$14,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted a like sum. The survey of the San Joaquin Valley was continued, the mapping of the Cooperstown, Ripon, Bachelor Valley, Salida, Dickenson, Oakdale, Westport, Montpelier, Reservoir, and Westley 7½-minute quadrangles and of the valley portion of the Lone Tree 7½-minute quadrangle being completed and that of the Empire, Denair, and Waterford 7½-minute quadrangles and of the Copperopolis 15-minute quadrangle being commenced by Duncan Hannegan, W. N. Vance, A. O. Burkland, H. W. Peabody, J. B. Leavitt, F. A. Danforth, S. H. Birdseye, D. H. Watson, C. A. Stonesifer, and R. M. La Follette, the total area mapped being 687 square miles—609 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet, and 78 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Cressy, No. 5, No. 6, Atwater, Planada, and Merced quadrangles, in Merced and Stanislaus counties, C. L. Nelson occupied 13 triangulation stations and marked 10.

In addition to the funds for regular cooperative surveys in California, \$2,500 was allotted by the University of California for the survey of the Santa Rosa quadrangle, in Napa and Sonoma counties, to be met by an equal amount by the United States Geological Survey from funds for 1915. The funds from the university were made available in the spring of 1914, and the survey of the Santa Rosa quadrangle was commenced by A. J. Ogle, the area mapped being 75 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of this area C. F. Urquhart and Mr. Ogle occupied 7 and marked 4 triangulation stations.

In addition to the cooperative work in California, the survey of the Seiad and Sawyers Bar quadrangles, in Klamath, Siskiyou, and Trinity national forests, in Humboldt, Siskiyou, and Trinity counties, was continued by J. P. Harrison, C. W. Wardle, C. A. Stonesifer, and J. W. Muller, the area mapped being 638 square miles, all in national forests, for publication on the scale of 1:125,000 with a contour interval of 100 feet.

A precise-level line was run by L. F. Biggs across the Tehachapi Pass from Bakersfield to San Pedro, 282 miles being run and 13 permanent bench marks established, in order to check elevations previously established so as to determine possible earth movement.

The revision of the map of San Francisco and vicinity was begun by J. P. Harrison, T. P. Pendleton, B. A. Jenkins, S. E. Taylor, F. A. Danforth, and C. A. Stonesifer, the area revised being 173 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet, covering portions of the San Francisco, Concord,



Haywards, and San Mateo quadrangles, in Alameda, Contra Costa, Marin, and San Francisco counties. In connection with this work the resurvey of the Mare Island quadrangle, the southwest quarter of the Napa quadrangle, in Napa and Solano counties, was begun by J. B. Leavitt, the area mapped being 86 square miles, for publication on the same scale as the revision work.

*California-Nevada.*—The survey of the White Mountain quadrangle, lying partly in the Inyo and Mono national forests, in Mono County, Cal., and Mineral and Esmeralda counties, Nev., was begun by T. P. Pendleton and D. H. Watson, the area mapped being 652 square miles, of which 160 square miles is in the national forests, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of the area mapped 272 square miles falls in California and 380 square miles in Nevada. For the control of this area Mr. Watson ran 49 miles of primary levels and established 14 permanent bench marks, this line being entirely in California.

*Nevada.*—The resurvey of the Yerington mining district, in the Wabuska and Wellington quadrangles, in Lyon County, was begun by R. H. Chapman and E. R. Bartlett, the area mapped being 58 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. For the control of this area Mr. Chapman occupied and marked 5 triangulation stations and ran 27 miles of primary levels and established 12 permanent bench marks. For the control of the Mina quadrangle, in Mineral County, D. H. Watson ran 50 miles of primary levels and established 6 permanent bench marks.

*Utah.*—The survey of the Logan quadrangle, in the Cache National Forest, in Box Elder, Cache, and Rich counties, was begun by H. H. Hodgeson and Howard Clark, the area mapped being 385 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. The resurvey of the Wellington quadrangle, in Carbon County, was continued, and that of the Vernal quadrangle, in Uinta County, was begun by Oscar Jones, E. R. Bartlett, Cornelius Schnurr, and E. C. Burt, the total area mapped being 904 square miles—159 square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet, and 745 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet. For the control of the Logan, Vernal, and Corinne quadrangles Mr. Jones and Mr. Hodgeson occupied 16 triangulation stations and marked 9, and for the control of the Logan, Vernal, and Randolph quadrangles Mr. Clark and Mr. Burt ran 205 miles of primary levels and established 50 permanent bench marks. Profile surveys of Green, Uinta, and White rivers, in the Vernal quadrangle, were made by Mr. Schnurr, the distance traversed being 114 linear miles, for publication on the scale of 1:48,000, with contour intervals of 5 and 25 feet.



*Hawaii*.—Cooperative topographic surveys were continued in the Hawaiian Islands under an arrangement similar to that of the previous fiscal year, the Territory allotting \$16,000 and the United States Geological Survey \$5,000. In the spring of 1914 the Territory allotted an additional \$1,000 which was not met by Federal funds. The survey of the island of Hawaii was continued, the area mapped being 342 square miles, for publication on the scale of 1:31,680, with a contour interval of 10 feet. This work covered portions of the Kohala, Waipio, and Hilo 15-minute quadrangles, the first two being completed, and was done by A. T. Fowler, A. O. Burkland, Olinus Smith, J. M. Rawls, N. E. Ballmer, and S. H. Birdseye. For the control of these areas Mr. Fowler occupied 4 triangulation stations and marked 1, and ran 43 miles of primary traverse, and Mr. Ballmer ran 44 miles of primary levels and established 7 permanent bench marks.

The work of making tracings of data acquired by the War Department for the preparation of a map of the entire island of Oahu on the scale of 1:48,000, with a contour interval of 40 feet, was continued, and the edges of the various sheets adjusted and joined and boundary lines shown.

#### OFFICE WORK.

The drafting of the following sheets was completed: Hereford, Maricopa, and Mesa (revision), Ariz.; Bachelor Valley, Cooperstown, Lone Tree Valley, Mojave, Montpellier, Dickenson, Oakdale, Patterson, Reservoir, Ripon, Romain, Salida, Searles Lake, Soledad, Thalheim, Trigo, Westley, and Westport, Cal.; Honomu, Kohala, and Waipio, Hawaii.

Progress in the drafting of additional sheets was made as follows: Napa, Cal., 66 per cent; San Francisco and vicinity (revision), Cal., 88 per cent; Seiad, Cal., 45 per cent; White Mountain, Cal.-Nev., 16 per cent; Yerington mining district, Nev., 55 per cent; Logan, Utah, 20 per cent; Vernal, Utah, 73 per cent; Wellington, Utah, 99 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Don Luis and Pearce (Ariz.), Searles Lake and Crucero (Cal.), Wabuska and Wellington (Nev.), Logan, Randolph, and Vernal (Utah), Hilo, Honomu, Kohala, and Waipio (Hawaii) quadrangles and for the Yerington mining district (Nev.).

Geographic positions were computed for the Boyles and Nutriosa (Ariz.), Wabuska and Wellington (Nev.), and Logan (Utah) quadrangles, and for the Yerington mining district (Nev.), and 62 positions were computed for the San Joaquin Valley (Cal.). Preliminary computations were made for the Searles Lake, Crucero, Ivanpah, and Santa Rosa (Cal.), and Vernal (Utah) quadrangles.

## INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

J. H. Renshawe spent August, September, and October in inspecting the work of various field parties in the Atlantic and Central divisions. W. M. Beaman inspected field work in the vicinity of Washington, D. C., during portions of July, November, and December, and in August, September, October, and November visited topographic parties in the Atlantic, Central, Rocky Mountain, Northwestern and Pacific divisions.

The office duties of Messrs. Renshawe and Beaman, as heretofore, involved careful supervision of the inking and preparation of the final drawings of the topographic branch and their examination prior to submission for engraving. Mr. Beaman's duties also included the examination of river-survey and other sheets prepared for photolithography and the examination and transmission of land classification, woodland, and other special information; attention to referred matters, largely from the editor of topographic maps, and the proper transmission of all original topographic map manuscript. A considerable portion of Mr. Renshawe's time, as stated on page 89, was spent in preparing colored relief maps of national parks.

## INSTRUMENTS AND TOPOGRAPHIC RECORDS.

As in past years, the repairs to all topographic instruments were made under the supervision of E. M. Douglas, who also had charge of the topographic records.

The additions to the topographic records consisted of 284 triangulation and primary-traverse field and computation books, 193 level books, not including the rodman's books, which were given duplicate numbers, 330 vertical-angle or stadia books, 36 plane-table sheets, and 60 envelopes of field data, all of which have been numbered and catalogued.

## MAP OF THE UNITED STATES.

Of the work in progress last year on the 1:1,000,000 scale map of the United States, under the direction of A. F. Hassan, base maps of the following States have been completed: New Hampshire (portions of sheets K 18 and 19 and L 19), Virginia (portions of sheets J 17 and 18), West Virginia (portions of sheets J and K 17 and J 18), Kentucky (portions of sheets J 16 and 17), Missouri (portions of sheets J and K 15 and J 16), and Washington (portions of sheets L and M 10 and 11). The adjustment of the township lines and 50 per cent of the compilation in Oregon (portions of sheets K and L 10 and 11), the contouring of sheets I and J 10, and 85 per cent of the contouring of sheet K 18 were completed. The States of Missouri and Washington cooperated in the preparation of maps of those States.

**WATER-RESOURCES BRANCH.****ORGANIZATION AND SCOPE OF WORK.**

The water-resources branch includes three divisions—surface water, ground water, and water utilization—each of which is appropriately subdivided into sections for field work. The organization of the branch is as follows:

Chief of branch, N. C. Grover, chief hydraulic engineer.

Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.

Division of ground waters, O. E. Meinzer, assistant geologist, in charge.

Division of water utilization, N. C. Grover, chief hydraulic engineer, in charge.

**PERSONNEL.**

The technical force of the water-resources branch has been reduced 8 during the year by transfers, resignations, and deaths, and has been increased by the appointment of 14 junior engineers, a net increase of 6. At the end of the year the technical force consisted of 1 chief hydraulic engineer, 8 hydraulic engineers, 1 engineer, 1 hydrographer, 1 chemist, 26 assistant engineers, 2 assistant geologists, 1 assistant chemist, 32 junior engineers, 1 junior chemist, and 2 geologic aids, a total of 76. Of this number, 1 hydraulic engineer, 2 assistant engineers, 1 assistant chemist, and 2 junior engineers are on furlough, and 1 hydrographer and 3 assistant engineers are employed occasionally at a per diem compensation.

**ALLOTMENTS.**

The appropriation was the same as in the preceding year (\$150,000). The cooperative funds made available by allotments by States have been increased in some States and decreased in others, making necessary corresponding adjustments of the work.

The appropriation for the fiscal year was allotted as follows:

*Allotments of appropriation for investigation of water resources, 1913-14.*

Administrative expenses of the Survey-----	\$12, 000
Branch administration-----	9, 420
Computations and reports-----	13, 475
Inspection-----	1, 000
Stream gaging in—	
Vermont-----	900
Massachusetts-----	2, 250
New York-----	2, 500
Virginia and Maryland-----	500
North Carolina, South Carolina, Georgia, Tennessee, and Florida-----	4, 150
Ohio Valley-----	6, 000
Minnesota-----	3, 500
Wisconsin-----	1, 800
Iowa-----	500

## Stream gaging in—Continued.

Colorado and Wyoming	\$6, 500
Montana	4, 500
North Dakota	450
Utah	4, 500
Nevada	2, 500
Idaho	4, 500
Oregon	4, 500
Washington	4, 500
California	4, 500
New Mexico	4, 500
Arizona	3, 000
Hawaii	5, 000
Yellowstone and Glacier national parks	550
Investigation of ground waters, including quality of waters	16, 800
Land-classification board	12, 500
Water-power investigations	12, 000
Débris investigations	1, 105
	<hr/> 150, 000

Of the total appropriation, 74 per cent was allotted for work in public-land States.

## COOPERATION.

## STATES.

Cooperative funds were allotted by several States as follows:

*Amounts allotted by States for cooperative work with United States Geological Survey in investigation of water resources.*

Arizona	\$3, 000
California :	
State engineer	\$9, 000
Conservation commission	7, 500
	<hr/> 16, 500
Connecticut	1, 000
Hawaii	15, 000
Idaho	9, 000
Iowa	500
Massachusetts	3, 000
Minnesota	3, 500
Nevada	2, 500
New Mexico	12, 000
New York :	
State engineer	\$1, 500
Conservation commission	10, 000
	<hr/> 11, 500
Oregon	10, 000
Utah	5, 500
Vermont	1, 200
Washington	5, 000
Wisconsin	8, 500
	<hr/> 107, 700

The work done under cooperative agreements in the several States has been limited to stream gaging, except as indicated below.

*California.*—In addition to a large amount of stream-gaging work in California, investigations of ground water in Sacramento and Santa Clara valleys were continued during the year and are still in progress. Measurements of depths to ground-water level were made in southern California. Reports containing the results of hydro-metric investigations were prepared and published.

*Connecticut.*—The cooperative work in Connecticut consisted chiefly of ground-water surveys.

*Hawaii.*—In addition to the stream-gaging work in Hawaii measurements of precipitation and studies of water losses in irrigation canals are being made.

*Idaho.*—Studies of the losses and gains in the rivers and irrigation systems of a portion of Idaho have been made at the request of the State engineer in conjunction with the regular stream gaging.

*Oregon.*—Special reports on Deschutes River and on the chemical composition of river waters of Oregon are now in press. A complete report on stream-flow investigations in Oregon is being compiled.

*Utah.*—A detailed study of the water supply and the present and possible future use of Sevier River is in progress.

In addition to the cooperative work described above, in which the States have furnished money for examinations made by the Survey staff, investigations of ground waters in cooperation with the agricultural experiment stations of New Mexico and Arizona were continued as in previous years. The contributions of the experiment stations consisted in making analyses of samples of water and soluble salts collected during ground-water surveys in these States.

#### RECLAMATION SERVICE.

Cooperation with the Reclamation Service in stream-gaging work has been continued as in previous years. The gaging stations operated at the expense of the reclamation fund are located on streams relied on to furnish water to reclamation projects under construction by that Service. The field work of stream gaging is done by Survey engineers who are engaged in such work in the locality, and repayment of actual cost is made by the Reclamation Service through a transfer of funds.

#### OFFICE OF INDIAN AFFAIRS.

Investigations and reports have been made by the Survey at the request of the Commissioner of Indian Affairs in connection with the classification of lands within Indian reservations with regard to water-power and reservoir sites and for the purpose of locating ground-water supplies, as follows:

*Flathead Reservation.*—The report on the power-site and reservoir possibilities on the Flathead Reservation was made under authority dated January 24, 1913.

*Klamath Reservation.*—A report was made on the power-site and reservoir possibilities of the Klamath Reservation under authorization of October 12, 1911.

*Moki and Navajo reservations.*—The investigation of the occurrence and availability of ground-water supplies in the Moki and Navajo reservations, authorized April 11, 1913, was continued in the field during July and a part of August, and a report thereon was sent to the Office of Indian Affairs.

An investigation of the possibility of developing water power on Hogback canal, located in T. 12 N., Rs. 1 and 2 W., and T. 13 N., R. 2 W., New Mexico meridian, in the Navajo Reservation, has been made under authority dated July 2, 1913, but the report thereon has not been filed.

*San Carlos Reservation.*—An investigation to determine the practicability of developing ground-water supplies for irrigation on the San Carlos Reservation was authorized May 25, 1914, and plans have been made to begin the field work soon after July 1.

*Wind River Reservation.*—Under authority dated July 2, 1913, power-site and reservoir possibilities on the Wind River Reservation were examined, but no report thereon has been made.

*Yakima Reservation.*—A report was made on the power-site and reservoir possibilities of the Yakima Reservation, under authorization of September 5, 1912.

*Stream gaging.*—Stream-gaging work has been continued on the following Indian reservations in accordance with authorizations of the Office of Indian Affairs: Colville, Crow, Fort Hall, Klamath, Menominee, Pine Ridge, Queniult, Rosebud, San Carlos, Standing Rock, Warm Springs, and Yakima.

#### PUBLIC-HEALTH SERVICE.

Special stream-gaging work is being done in the Ohio River basin in cooperation with the Public-Health Service in connection with an investigation of the pollution of that river.

#### CITY OF SAN FRANCISCO.

Stream gaging is in progress on Tuolumne River, in California, in cooperation with the city of San Francisco, in connection with the utilization of the water of that river, to be stored in the Hetch Hetchy Valley as a water supply for the city.

#### PUBLICATIONS.

The work of the water-resources branch during the year is represented by 15 water-supply papers and 6 advance chapters. Titles and brief summaries of these publications are given on pages 25–28. Thirty-three other publications were in press at the close of the year and five manuscripts were in hand awaiting editing.



## DIVISION OF SURFACE WATERS.

## ORGANIZATION.

The work of the division of surface waters consists primarily of the measurement of the flow of rivers. Incidental to this work special investigations are made relative to conditions affecting stream flow and its utilization. For this work the United States is divided into 14 districts, including Hawaii. Two of these districts were established during the year—(1) New Mexico and Arizona and (2) Washington—and the Alaska district was discontinued.

Each district office is supervised by a district engineer, assisted by a trained corps of engineering and clerical assistants. The following list gives the districts, the name of the district engineer, and the location of each district office and suboffice:

North Atlantic district: C. C. Covert, district engineer, Federal Building. Albany, N. Y.

Middle Atlantic district: G. C. Stevens, Washington, D. C.

South Atlantic and eastern Gulf district: Warren E. Hall, district engineer, Federal Building, Atlanta, Ga.

Ohio Valley district: A. H. Horton, district engineer, Federal Building, Newport, Ky.<sup>1</sup>

Upper Mississippi River district: W. G. Hoyt, district engineer, Capitol Building, Madison, Wis.; suboffice, Old Capitol Building, St. Paul, Minn.

Upper Missouri district: W. A. Lamb, district engineer, Montana National Bank Building, Helena, Mont.

Rocky Mountain district: Robert Follansbee, district engineer, Chamber of Commerce Building, Denver, Colo.

Great Basin district: E. A. Porter, district engineer, Federal Building, Salt Lake City, Utah.

Idaho district: G. C. Baldwin, district engineer, Idaho Building, Boise, Idaho.

Oregon district: Fred F. Henshaw, district engineer, Couch Building, Portland, Oreg.

Washington district: G. L. Parker, district engineer, Federal Building, Tacoma, Wash.

California district: H. D. McGlashan, district engineer, Customhouse, San Francisco, Cal.; suboffice, Federal Building, Los Angeles, Cal.

Arizona and New Mexico district: G. A. Gray, district engineer, Capitol Building, Santa Fe, N. Mex.; suboffice, 610 North Sixth Avenue, Phoenix, Ariz.

Hawaiian district: G. K. Larrison, district engineer, Kapiolani Building, Honolulu.

## CHARACTER AND METHODS OF WORK.

From the district offices field investigations incident to the work are made, and the results are sufficiently analyzed to insure that they are both accurate and complete. Places known as gaging stations are selected, at which sufficient measurements of discharge and other data are collected for determining the daily flow. At the end of the

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<sup>1</sup> Office temporarily closed during later part of year; work conducted from Washington office.



year 1,371 gaging stations were maintained, exclusive of those in Alaska. During the year 445 stations were discontinued and 425 stations established. In addition records ready for publication were received for about 250 stations from other Government bureaus and private persons. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or private persons.

The following table shows the distribution of the stations and measurements by States and also indicates the number of stations maintained by cooperating parties:

*Report of gaging stations and cooperating parties for the year ending June 30, 1914.*



<sup>a</sup> Total, June 30, 1913, should have been 110 instead of 97, 13 stations having been omitted.

The results of field data collected from the district offices are transmitted to the Washington office, where they are reviewed in the computing section and prepared for publication. This review not only

insures accuracy in the data but also brings the results from different parts of the country to a uniform standard. A regular field inspection is also maintained, whereby the standard of the work in the several districts is made uniform.

#### PUBLICATIONS.

The results of stream measurements are published in an annual progress report, divided into 12 parts. The following table gives the titles of these 12 parts and the numbers of the papers containing the data for each region during the last five years. Prior to 1913 the publication year had been made to coincide with the calendar year. Beginning with 1913, the seasonal or climatic year, October 1–September 30, has been adopted for reports on regions west of the Rocky Mountains and on the upper Mississippi and Ohio rivers, and in future reports for the whole country the records published will cover seasonal years.

*Numbers of water-supply papers containing results of stream measurements, 1909–1913.*

CONTINUED

\* Great Basin in California, excepting Truckee and Carson drainage basins.

In addition to the regular progress reports, special reports on various hydraulic subjects have been completed for publication during the year, as indicated in the list given on pages 25–28.

#### DIVISION OF GROUND WATERS.

##### SCOPE OF WORK.

The main function of the division of ground waters is to make a survey of the waters that occur below the surface of the ground, with reference to their utilization. Certain areas are investigated each year, these investigations forming a part of a comprehensive plan that includes the entire country. In recent years the methods of work have been further standardized and special attention has been given to detailed surveys of the mineral character of the ground waters and to quantitative determinations of the underground supplies annually available in specific areas. Because of the great interest

throughout the West in irrigation with ground water and the prospects for important developments along this line, most of the work has been done in the arid and semiarid States and with special reference to irrigation.

The chemical and sanitary investigations, which are under the direct supervision of R. B. Dole, cover both surface and ground waters. During the year progress was made in the preparation of a comprehensive report on the quality of the surface waters of the United States by Mr. Dole, assisted by E. C. Bain. Mr. Dole also prepared the chapter on the production of mineral waters and a discussion of the radioactivity of mineral waters for the annual volume *Mineral Resources of the United States*.

Maps and manuscripts for geologic folios were reviewed and parts relating to ground waters were prepared.

During the year investigations of ground waters or quality of water were in progress in 19 States, as follows: Arizona, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Kansas, Louisiana, Montana, Nebraska, Nevada, New Mexico, Oklahoma, Oregon, Texas, Utah, Washington, and Wyoming. The work in Arkansas, Florida, Georgia, and Texas was done in cooperation with the section of Coastal Plain investigations of the geologic branch, and the work in Idaho was done by the division of water utilization.

#### WORK BY STATES.

*Arizona.*—The report on the geology and water resources of Sulphur Spring Valley, Ariz., prepared by O. E. Meinzer, of the Federal Survey, in cooperation with R. H. Forbes and F. C. Kelton, of the State Experiment Station, was published as Water-Supply Paper 320.

Ground-water investigations, which for several years have been conducted for the Office of Indian Affairs in the Moki and Navajo reservations, in Arizona and adjacent parts of New Mexico and Utah, were continued during the year by H. E. Gregory, assisted by W. B. Emery and K. C. Heald. A report was submitted to the Commissioner of Indian Affairs on the results of the field work done in the summer of 1913, and much progress was made by Prof. Gregory in the preparation of a comprehensive report for publication as a water-supply paper, based on all the work that has been done in this region.

A few weeks was spent by A. T. Schwennesen in the San Simon Valley for the purpose of obtaining well data, measuring the flow and pressure of artesian wells, and collecting samples of well waters. This investigation, which is to be continued next year, is being conducted in cooperation with R. H. Forbes, director of the Arizona Experiment Station.

*Arkansas.*—The report on the geology and ground-water resources of eastern and northeastern Arkansas, by L. W. Stephenson and

A. F. Crider, with a discussion of the chemical character of the waters, by R. B. Dole, was completed by the authors.

*California.*—An investigation of the underground storage of flood water by artificial methods in the San Bernardino Valley, conducted by C. H. Lee, through cooperation with the California State Conservation Commission, was completed in the previous year, and the results were published in the report of the commission.

The report on California springs, by G. A. Waring, was completed and is in press.

The final report on ground water in the San Joaquin Valley, by W. C. Mendenhall, R. B. Dole, and Herman Stabler, has been delayed because of the heavy duties of two of the authors on the land-classification board, but it is now nearly finished. Progress has also been made by Mr. Mendenhall in the preparation of the San Jacinto report.

Ground-water investigations were continued in the Sacramento Valley by Kirk Bryan. The field work was nearly completed and good progress was made in the preparation of a report on this area. The analytical work was done by S. C. Dinsmore, of the Nevada Experiment Station and Food and Drug Commission, and G. H. P. Lichthardt, city chemist, Sacramento.

Progress was also made in the investigations of the Santa Clara Valley by W. O. Clark, and a report on the water supply of the Niles cone has been practically completed by Mr. Clark.

Since 1900 the Geological Survey has, at more or less irregular intervals, made measurements of the depth to water in certain wells in southern California. At the beginning of this fiscal year arrangements were made for the continuation of these measurements at regular intervals. The measurements this year were made by F. C. Ebert.

The sanitary condition of Yosemite National Park was investigated by Mr. Dole, and a report thereon, with recommendations for improvements, was submitted to the Secretary of the Interior.

*Connecticut.*—Investigations in Connecticut were continued in cooperation with the State Geological and Natural History Survey. A report on the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, by H. E. Gregory and A. J. Ellis, was completed. Field work was done by Mr. Ellis in the Waterbury area and the Pomperaug Valley, and a report on the Waterbury area was nearly completed by him.

*Florida.*—The report on the geology and ground waters of Florida, by G. C. Matson and Samuel Sanford, prepared in cooperation with the Florida Geological Survey, was published as Water-Supply Paper 319. Progress was also made by R. B. Dole in the preparation of a report on the quality of the ground waters of Florida.

A report on some chemical characteristics of sea water at Tortugas and around Biscayne Bay, by Mr. Dole, was issued in publication 182 of the Carnegie Institution of Washington.

*Georgia.*—The report on the ground waters of the Coastal Plain of Georgia, by L. W. Stephenson and Otto Veatch, with a discussion of the chemical character of the waters by Mr. Dole, is in press as Water-Supply Paper 341. The investigation on which this report is based was conducted in cooperation with the Georgia Geological Survey.

*Idaho.*—Data on ground water in southeastern Idaho were collected by W. B. Heroy and V. E. J. Mayer for purposes of land classification. These data were filed with the land-classification board.

*Kansas.*—A brief investigation of the ground-water supply available for irrigation in the vicinity of Wichita was made by Mr. Meinzer in November, 1913, and a report thereon was published in February, 1914, as Water-Supply Paper 345-A.

*Louisiana.*—Sixty samples of water from the mouth of Mississippi River were analyzed by Mr. Bain and a report thereon submitted to the geologic branch. This work was done in connection with a study of the Mississippi Delta by E. W. Shaw.

*Montana.*—The report on the water resources of Butte was completed by Mr. Meinzer and will be issued as Water-Supply Paper 345-G.

The sanitary condition of Glacier National Park was investigated by Mr. Dole, and a report thereon, with recommendations for certain improvements, was submitted to the Secretary of the Interior.

*Nebraska.*—A brief investigation of the ground-water supplies available for irrigation in parts of southwestern Nebraska was made by N. H. Darton in the fall of 1913, and a short report on this area was published as a press bulletin under date of December 4, 1913.

*Nevada.*—The report on ground water in southeastern Nevada was completed by Everett Carpenter, and is in press as Water-Supply Paper 365.

Field work was done in the Big Smoky, Clayton, and Klondike valleys by Mr. Meinzer in September and October, 1913, and a report on this area was partly prepared. Analyses of water and soluble salts were made in connection with this investigation by S. C. Dinsmore.

*New Mexico.*—A preliminary report on ground water in Luna County was prepared by Mr. Darton and published as Water-Supply Paper 345-C. The final report on this area was also completed.

The report on the Tularosa Basin and adjacent areas, prepared by Mr. Meinzer, of the Federal Survey, in cooperation with R. F. Hare,

of the State experiment station, was sent to press and will be issued as Water-Supply Paper 343.

A number of pumping tests in the irrigated area of the Mimbres Valley were made by Mr. Schwennesen, in August, 1913, the results of which were published in Water-Supply Paper 345-C.

A ground-water survey of the southern part of Grant County, including the Animas, Playas, and Hachita valleys, was undertaken in cooperation with the State experiment station. The field work was completed, and at the close of the fiscal year work on the report was well advanced. The field investigations and the preparation of the report were assigned to Mr. Schwennesen, of the Survey, and the analytical work is being done by Dr. Hare, of the experiment station.

The report on the ground waters of the Moki and Navajo reservations, which is being written by Prof. Gregory, covers a part of northwestern New Mexico.

*Oklahoma.*—Brief examinations of the vicinity of Enid and of the valley of the North Fork of Canadian River near Oklahoma City were made by Mr. Schwennesen in January, 1914, to determine the practicability of developing irrigation supplies from underground sources, and reports based on this work were published as Water-Supply Papers 345-B and 345-D, respectively.

*Oregon.*—The report on the quality of the surface waters of Oregon, by Walton Van Winkle, which is based on an investigation conducted in cooperation with J. H. Lewis, State engineer of Oregon, was completed and sent to press as Water-Supply Paper 363.

*Texas.*—The work in Texas this year was confined to the Coastal Plain and was conducted in cooperation with the section of Coastal Plain investigations.

The report on the geology and ground-water resources of Texas east of Brazos River, by Alexander Deussen, was completed and sent to press as Water-Supply Paper 335.

A similar report on the area between Brazos and Guadalupe rivers, by Messrs. Deussen and Dole, is nearly completed. Other reports covering the section from Guadalupe River to the Rio Grande, by Messrs. Deussen, Stephenson, Matson, and Dole, are in progress. A report on the ground-water supply of La Salle, McMullin, and Dimmit counties, by Messrs. Deussen and Dole, was nearly completed.

*Utah.*—The report on ground water in Box Elder and Tooele counties, prepared by Mr. Carpenter, was published as Water-Supply Paper 333. The investigations that were conducted in the Moki and Navajo reservations include a part of southeastern Utah.

*Washington.*—The report on the quality of the surface waters of Washington, prepared by Mr. Van Winkle, in cooperation with the State Board of Health, is in press as Water-Supply Paper 339.

*Wyoming.*—The sanitary condition of Yellowstone National Park was investigated by Mr. Dole and a report thereon, with recommendations for certain improvements, was submitted to the Secretary of the Interior.

#### DIVISION OF WATER UTILIZATION.

The organization of the division of water utilization has been continued during the year as described in previous annual reports. E. C. La Rue and E. C. Murphy, hydraulic engineers, have performed the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. The work of examining land for designation under the enlarged-homestead act has been done in part by Mr. La Rue and Mr. Murphy and in part by W. B. Heroy, geologist, W. N. White, assistant classifier, and V. E. J. Mayer, junior clerk, in the land-classification board, who were detailed to the work during a portion of the field season. In addition to the routine field work of the division, Mr. La Rue has devoted several weeks to the preparation of a manuscript for publication relative to the present and probable future utilization of Colorado River for irrigation, power, and navigation; and Mr. Murphy has spent about three months in the field examination of the possibilities of water-power and reservoir development in Arizona in order that designation of lands valuable for such purposes may be made in accordance with the act of Congress admitting Arizona to statehood.

#### LAND-CLASSIFICATION BOARD.

##### GENERAL FEATURES.

The land-classification board has had no important changes in its personnel and its work has followed essentially the lines of the previous fiscal year. The energies of its staff have been devoted largely to the expeditious promulgation of public-land classifications based on the field work of the other branches of the Survey, the continuation of the cooperative correspondence with other bureaus of the department, by which the technical information in the Survey is rendered available in public-land administration, and the preparation of special reports of widely diverse character for various governmental organizations.

At the close of the year the board's staff contained 34 permanent employees, of whom 9 are geologists, 4 engineers, 3 draftsmen, 16 clerks, and 2 messengers.

##### SPECIAL FEATURES.

Among the items of particular importance in the work of the board during the year, the large volume of coal and phosphate classifications has a prominent place. More than 8,250,000 acres of lands withdrawn for coal classifications were classified and restored to



entry during the year and more than 1,400,000 acres additional were classified for early restoration. Nearly 1,300,000 acres of coal lands were appraised and were made available for purchase at the appraised prices. This work increases the total of appraised lands to more than 19,600,000 acres at the close of the fiscal year. The average price of the lands thus appraised is slightly less than \$40 an acre.

Progress has also been made in the examination of withdrawn phosphate lands. Nearly 3,000,000 acres were included in withdrawals on July 1, 1913, and approximately 1,700,000 acres were examined during the fiscal year. The results of this examination will appear in extensive modifications of the outstanding withdrawals by large restorations and much smaller additional withdrawals.

An additional large element in the work of the board is the classification for the Office of Indian Affairs of somewhat more than 2,400,000 acres of lands in the various reservations. These classifications were based on the field work of the fiscal years 1912-13 and 1913-14, and were made at the request of the commissioner to assist in the proper disposition of the Indian lands.

Several special reports were prepared during the year upon power developments on the public domain and upon the interrelations of the companies engaged in the development of hydroelectric energy. Most of these special reports were prepared for the department, but a large body of data bearing on power developments and control was supplied to the Committee on Public Lands of the House of Representatives to assist it in its consideration of the Ferris water-power bill (H. R. 14893). These data have been published as Exhibit N of the hearings on this bill before the Committee on Public Lands, Sixty-third Congress, second session.

No new legislation providing for the disposition of the reserved coal, oil and gas, phosphate, or potash deposits of the public domain has been enacted during the year, but the outlook for such legislation was brighter at its close than at any time since the question has been seriously agitated.

These various factors of the board's activities are reflected in a measure in the volume of its correspondence. During the year 15,515 letters were referred to the board, and 19,356 reports, letters, and notifications were prepared by the board. This is an average of 52 incoming pieces of mail and about 64 outgoing pieces for each working-day—a record that is not substantially different from that of the preceding year.

#### COOPERATIVE CORRESPONDENCE.

In November, 1913, in order to expedite the disposition of cases in the department, the cooperative agreement between the General

Land Office and the Geological Survey, which forms the basis of the cooperative correspondence, was partly suspended. Although this partial suspension permitted the patenting of land to land-grant railroads and others without scrutiny as to its mineral character, it enabled the Geological Survey to dispose of practically all its accumulated cases by the close of the fiscal year.

The suspension did not affect cases involving withdrawn lands, cases already referred to the Survey, claims for small holdings, Santa Fe Pacific selections, Indian allotments, or cases in Alaska and California. These cases, together with those received between the opening of the fiscal year and the suspension of the agreement, aggregate 4,478 requests for information received during the year, and 2,711 field-service reports for action. The Survey furnished information in 7,628 cases and acted on 3,620 field-service reports, leaving 199 requests for information and 197 field-service reports pending. Thus the Survey is practically current in this work and should be able to keep current on the resumption of the agreement.

The following table shows the year's record in the several classes of cooperative cases, including those discussed more particularly under the work of the hydrographic and mineral divisions and including also enlarged-homestead petitions, which, while not cooperative cases, are sufficiently similar in the methods by which they are handled to be appropriately considered in the same connection.

*Balance sheet of cooperative cases for the year ended June 30, 1914.*

Class of cases.	Pending July 1, 1913.	Received.	Disposed of.	Pending June 30, 1914.	Gain (+) or loss (-).
Involving mineral character only:					
Land Office requests for information.....	60	223	271	12	+ 48
Land Office field-service reports.....	275	1,237	1,427	85	+ 190
Applications for reclassification, coal.....	15	16	31	0	+ 15
Applications for classification, coal.....	.....	43	40	3	- 3
	350	1,519	1,769	100	+ 250
Involving water resources only:					
Land Office requests for information.....	43	306	335	14	+ 29
Land Office field-service reports.....	16	85	85	16	0
Forest-reserve cases.....	28	63	89	2	+ 26
Applications for reclassification, power.....	19	46	52	13	+ 6
Right-of-way applications.....	58	503	451	110	- 52
Carey Act lists.....	0	19	19	0	0
Enlarged-homestead petitions.....	1,347	5,709	5,399	1,657	- 310
Desert-land proofs under irrigation projects.....	15	219	115	119	- 104
	1,526	6,950	6,545	1,931	- 405
Involving both mineral character and water resources:					
Land Office requests for information.....	2,611	3,055	5,529	137	+2,474
Land Office field-service reports.....	180	495	615	60	+ 120
Land Office requests for information as to water resources, accompanied by field-service reports as to mineral character.....	635	894	1,493	36	+ 599
Indian Office cases.....	319	1,278	1,562	85	+ 284
	3,745	5,722	9,199	268	+3,477
	5,621	14,191	17,513	2,299	+3,322

## MINERAL CLASSIFICATIONS.

## COAL.

The regulations governing the classification and valuation of coal lands approved by Secretary Fisher February 20, 1913,<sup>1</sup> have been in force during the fiscal year. Although not materially affecting the classification and valuation of the lignite-bearing lands as accomplished under the old procedure, these regulations have furnished a more rational basis for the classification and valuation of the lands containing coal of higher grade. This result has been attained mainly through the graded allowance for maximum workable depth with beds of different thicknesses and the decreased prices charged for lands underlain by thin coal beds.

*Withdrawals and restorations.*—The fiscal year has shown a notable decrease in the area of land included in outstanding withdrawals of coal lands, as the lands classified and restored have exceeded the area withdrawn during the year by over 8,250,000 acres.

*Classifications.*—Every effort has been made during the year to hasten the classification and appraisal of coal lands and to obtain information regarding the withdrawn areas which were believed to be largely noncoal lands, in order that these areas might be eliminated from the withdrawals. During the year over 1,350,000 acres were classified as coal land and over 8,335,000 acres were classified as non-coal land. The greater part of the area classified as coal land is in the region of the medium and low grade coals in northeastern Wyoming, eastern Montana, and North Dakota, although several small areas of high-grade coal in Utah, Colorado, and New Mexico have been examined and classified. No small part of the work has been the classification of lands in Indian reservations that were thrown open to settlement.

The following three tables summarize the withdrawals, restorations, classifications, and valuations by States during the fiscal year:

*Coal land withdrawn and restored during year ended June 30, 1913, in acres.*

<sup>1</sup> U. S. Geol. Survey Bull. 537, pp. 96-97, 1913.

*Coal land classified to June 30, 1914, in acres.*

<sup>a</sup> Decrease in noncoal area during fiscal year due to reclassification of 2,615 acres as coal land.

*Valuation of coal lands.*

State	Appraised prior to July 1, 1913.	Appraised during fiscal year 1914.	Total out- standing appraised June 30, 1914.	Total valuation of ap- praised coal land.	Average value per acre.
	<i>Acres.</i>	<i>Acres.</i>	<i>Acres.</i>		
Arkansas..	60,715	.....	60,715	\$1,473,763	\$24.20
California.....	7,720	.....	7,720	585,086	75.70
Colorado.....	2,844,202	27,718	2,871,920	168,490,129	58.60
Idaho.....	2,113	.....	2,113	51,824	24.50
Montana.....	4,550,945	180,676	4,731,621	116,710,126	24.60
Nevada.....	5,880	.....	5,880	117,000	20.00
New Mexico..	953,772	4,696	958,467	21,257,867	22.10
North Dakota...	1,775,497	323,827	2,099,324	34,062,345	16.20
Oregon.....	1,897	2,775	4,672	79,259	16.90
South Dakota...	249,897	.....	249,897	2,756,427	11.00
Utah.....	670,272	378,229	1,048,501	44,315,401	42.30
Washington....	40	60	100	3,200	32.00
Wyoming.....	7,180,509	381,420	7,561,929	387,401,682	51.20
	18,303,459	1,299,400	19,602,859	777,305,698	39.60

During the last year, as during preceding years, the sales of coal lands at valuations fixed under departmental regulations have continued as the lands have been required by the coal-mining industry. The policy of withdrawal and classification established in 1906 has had two principal effects: (1) It has largely put an end to the earlier prevalent practice of acquiring large areas of coal lands under other laws than the coal-land law; (2) it has practically stopped purchase under the coal-land law itself for idle speculative holdings. There is no indication, however, that those who really wish to establish mines hesitate to purchase at Government valuations. Indeed, many requests are received in the course of a year for the early valuation of lands in order that they may be purchased for development. The following table shows the sales made since June 30, 1899. The table is divided into two parts, one showing the sales during the 8 years preceding the adoption of the classification policy, the

other showing the sales for the 7 years since. Some of the figures in this table differ from those published in preceding annual reports because the earlier tables had been based on preliminary reports of sale furnished by the General Land Office or obtained from its records, and some of these preliminary figures differ from the final figures published in the annual reports of the commissioner. The table now presented is based on the official published figures of the commissioner except for the year ending June 30, 1914. Preliminary figures only are available for this year and they are subject to correction in later reports.

*Sales and prices of coal land in United States, exclusive of Alaska, from July 1, 1899, to June 30, 1914.*

Year.	Number of entries.	Area.	Amount.	Average price per acre.
<i>Eight years prior to July 1, 1907.</i>				
1900.....	82	11,401.91	\$210,338.70	\$18.45
1901.....	84	10,955.91	207,933.00	18.97
1902.....	88	12,575.46	174,683.30	13.89
1903.....	252	38,007.88	498,997.00	13.13
1904.....	190	28,827.42	395,209.90	13.74
1905.....	158	20,456.35	277,402.40	13.56
1906.....	244	42,143.39	538,683.70	12.78
1907.....	187	25,158.81	350,973.54	13.95
	1,285	189,527.13	2,654,221.54	14.00
<i>Seven years since July 1, 1907.</i>				
1908.....	303	44,821.12	636,663.18	14.20
1909.....	213	31,045.12	556,502.03	17.92
1910.....	248	38,325.26	772,325.41	20.15
1911.....	108	23,001.95	384,024.90	16.69
1912.....	68	9,053.34	430,767.58	47.58
1913.....	76	10,338.70	270,425.10	26.15
1914.....	71	9,306.33	307,487.95	33.04
	1,087	165,891.82	3,358,196.15	20.24
	2,372	355,418.95	6,012,417.69	16.91

Tables have been given in some preceding annual reports to show the number of acres sold and the prices realized since July 1, 1907. These tables, like the preceding tables, have been based on preliminary figures obtained from the General Land Office. These preliminary figures have differed, generally in minor degree, from the figures that finally appear in the reports of the General Land Office. The commissioner, however, does not publish detailed statements of the number of acres sold at each particular price, so that data are not available for correcting the preliminary figures, because there is no final compilation in this form. The following table therefore represents the preliminary figures furnished by the commissioner, showing by acres and prices per acre the sales during the year ended June 30, 1914, only:

Sales of coal lands at various prices during the fiscal year ended June 30, 1914.

Price per acre.	Area.	Amount.	Price per acre.	Area.	Amount.
\$10.....	2,354.37	\$23,543.70	\$130.....	40.00	\$5,200.00
15.....	120.00	1,800.00	135.....	80.00	10,800.00
20.....	4,435.19	88,703.80	140.....	201.20	28,168.00
25.....	872.61	21,815.25	240.....	40.00	9,600.00
28.....	40.00	1,120.00	250.....	80.00	20,000.00
30.....	201.01	6,030.30	260.....	80.00	20,800.00
32.....	80.00	2,560.00	275.....	40.00	11,000.00
34.....	40.00	1,360.00	280.....	40.00	11,200.00
50.....	400.46	20,023.00	300.....	40.00	12,000.00
55.....	40.00	2,200.00			
110.....	41.49	4,563.90		9,306.33	307,487.96
125.....	40.00	5,000.00			

*Applications for classification and reclassification.*—During the fiscal year the Survey received about 60 applications for the classification of withdrawn lands either as coal or noncoal land, and 16 applications for the revision of outstanding coal and noncoal classifications. Because many of these applications ask for noncoal classification in withdrawn areas regarding which the Survey has no detailed data, and because the evidence submitted by the applicant to show the noncoal character of the land has usually been of little value, few such requests have been granted. On the other hand, most of the applications for classification as coal land have related to lignite areas, and the applicants have been able to supply sufficient information to warrant the action requested. More than half of the applications for classification have been granted. The requests for reclassification have related mainly to the area of flat-lying lignite in eastern Montana where, because no coal is exposed on or near the land, claimants have been unwilling to accept the coal classification. Most of the applications of this character have been denied, only 3 out of 31 acted on having been granted.

OIL.

The classification of the public lands with reference to their prospective value for deposits of petroleum and natural gas was continued during the year in the States of California and Wyoming. In California about 120,000 acres in Kern, Los Angeles, and Orange counties were withdrawn from entry, and a little less than 100,000 acres in Monterey, Fresno, and San Benito counties, which field examinations by the Survey have shown to be barren of valuable accumulations of oil, were restored. In Wyoming, on the basis of geologic evidence resulting from detailed field investigations, nearly 89,000 acres in Park, Hot Springs, and Washakie counties were included in petroleum reserves, and about 90,000 acres, principally in Crook County but including small areas in Lincoln and Bighorn counties, were restored. The following table shows the results of oil-land classification during the year:

*Oil lands withdrawn and restored, fiscal year 1914, in acres.*

	Outstanding July 1, 1913.	New with- drawals.	Restora- tions.	Outstanding June 30, 1914.
Arizona.....	230,400			230,400
California.....	1,388,080	120,647	98,283	1,410,444
Colorado.....	87,474			87,474
Louisiana.....	414,720			414,720
Utah.....	1,952,326			1,952,326
Wyoming.....	523,138	88,841	89,584	522,395
	4,596,138	209,488	187,867	4,617,759

Of especial interest during the year was the modification by Executive order of Petroleum Reserve No. 8 in Wyoming, to the extent of permitting exploration for natural gas on certain areas within the reserve. The recommendation of this action was based on an urgent appeal by residents of Greybull and Basin, Wyo., for immediate relief from a fuel famine which threatened those communities, and the exigencies of the situation amply justified the relief measures adopted. This case illustrates the needs of many other communities and the hampered position of legitimate operators who would satisfy those needs were legislative means provided whereby the oil and gas resources of the public domain might be sanely developed.

**PHOSPHATE.**

There has been no change in the procedure as regards classification of phosphate lands during the fiscal year. The regulations governing the withdrawal and restoration of phosphate lands have not been modified since they were adopted by the Survey on March 2, 1912. Deposits containing less than 30 per cent of tricalcium phosphate are considered nonmineral lands. Phosphate beds that are from 1 foot to 6 feet or more in thickness and contain 70 per cent or more of tricalcium phosphate are held to depths ranging from zero along the outcrop to the maximum of 5,000 feet in direct ratio to the variation of thickness of bed from 1 to 6 feet. For beds containing less than 70 per cent of tricalcium phosphate the depth limit varies from zero to the depth of a 70 per cent bed of any given thickness in direct ratio to the variation in tricalcium phosphate content from 30 to 70 per cent.

Phosphate classification during the fiscal year was restricted largely to the withdrawn areas in Montana and Wyoming, but some additional work was done in the Fort Hall Indian Reservation, in eastern Idaho. The results of these detailed examinations have materially modified the outstanding phosphate reserves. As shown in the report on this subject for 1912-13, the restorations during that year exceeded the withdrawals by more than a quarter of a million



acres, with a corresponding reduction of the area of outstanding reserves. Field examinations for the fiscal year 1913-14 have resulted in further large eliminations from the reserves and only minor additions to the outstanding withdrawals. Approximately 1,700,000 acres were examined, and when action has been taken on all the data obtained the resulting restorations will more than double those of 1912-13. The results of the phosphate examinations for the fiscal year, in so far as action has been taken, are set forth in the following summary:

*Phosphate lands withdrawn and restored, fiscal year 1914, in acres.*

State.	Outstanding July 1, 1913.	With- drawals during fiscal year.	Restora- tions during fiscal year.	Outstanding June 30, 1914
Florida.....	120,457	.....	80	120,377
Idaho.....	916,769	84,507	.....	1,001,276
Montana.....	274,861	34,114	187,277	121,688
Utah.....	107,745	.....	71,552	36,193
Wyoming.....	1,502,724	51,264	.....	1,553,988
	2,922,556	169,885	258,909	2,833,532

No phosphate examinations were made by the Survey in Florida during the year, but 80 acres were restored to entry and four of the outstanding reserves were modified so as to permit the issuance of patent to certain agricultural lands on which valid settlement had been made. Only vacant lands in the general phosphate region are included in the phosphate withdrawals in Florida, but in order to guard against unnecessary interference with settlement the homesteader who may desire to enter withdrawn land may submit properly authenticated evidence, setting forth the reasons which seem to him to show that the land is nonphosphate. If the tests and the information submitted to the Survey prove the nonphosphate character of the land, it is recommended for restoration.

It should be noted that under the act of Congress approved July 17, 1914 (Public No. 28, 63d Congress), any form of nonmineral entry or selection may be made upon lands withdrawn, classified, or reported as containing phosphate, nitrate, potash, oil, gas, or asphaltic minerals, the United States reserving the deposits for which the lands are reported valuable, with the right to prospect for, mine, and remove them. Thus lands valuable for these minerals are available for agricultural use, in the same way that coal lands have been so available since 1910.

## POTASH.

Field work by the Survey in search of potash was continued during the fiscal year. As in previous years the work was largely of an exploratory character. It resulted in the withdrawal of 92,160 acres in the Black Rock Desert, Nev., and led to the restoration of some of the lands included in Potash Reserve No. 2, California No. 1.

The withdrawals and restorations are summarized below:

*Potash lands withdrawn and restored, fiscal year 1914, in acres.*

State.	Outstanding July 1, 1913.	With- drawals during fiscal year.	Restora- tions dur- ing fiscal year.	Outstanding June 30, 1914.
California.....	94,407	.....	320	94,087
Nevada.....	39,422	92,160	.....	131,582
	133,829	92,160	320	225,669

## METALLIFEROUS LANDS.

*Withdrawals.*—The only outstanding withdrawal of metalliferous land (the only one of its type that has been made) is Mineral Land Withdrawal No. 1, Arizona No. 1. The withdrawal covers an area in the Warren mining district, Bisbee, Ariz., and merely prevents the alienation under the nonmineral land laws of lands on which geologic conditions are believed to be favorable to the occurrence of deep-seated deposits of copper. Because of the depth of these deposits discovery and hence valid location will be difficult, and will depend on extensive drilling or deep shafting, and will require time. Meanwhile the lands in the withdrawn area are open to exploration and purchase under the mining laws, so far as they apply to metalliferous minerals, but are not subject to other forms of entry.

*Classifications.*—The act of February 26, 1895 (36 Stat., 683), made provision for classifying, with respect to their mineral or nonmineral character, the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho, the work to be done by commissioners appointed for the purpose. The classifications made in many areas were unsatisfactory, and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 703). At the request of the General Land Office the reclassification was made by the Geological Survey. Field examination of these lands was first undertaken by the Survey during the field season of 1910. The work was continued during the field season of 1911 and was completed in 1912, except on a few small tracts in Montana, which were examined in 1913. The results of the Northern Pacific classification work for the four years are shown in the following table:

*Lands in Northern Pacific Railroad grant in Idaho and Montana classified by the United States Geological Survey, in acres.*

State.	1910-11	1911-12	1912-13	1913-14	Total.
Idaho:					
Mineral.....	46,645	19,144	1,000	.....	65,789
Nonmineral.....	90,712	53,055	1,200	.....	144,967
Montana:					
Mineral.....	130,396	1,134	19,800	480	151,809
Nonmineral.....	21,802	83,981	65,570	7,696	179,049
Total:					
Mineral.....	176,031	20,278	20,800	480	217,589
Nonmineral.....	112,514	137,036	66,770	7,696	324,016
Grand total.....	288,545	157,314	87,570	8,176	541,605

Certain additional areas in Idaho, Montana, North Dakota, Oregon, Washington, and Wyoming were examined in the field.

Lands within the Flathead Indian Reservation, Mont.; Klamath Indian Reservation, Oreg.; Colville Indian Reservation, Wash.; Shoshone Indian Reservation, Wyo.; and Sullys Hill Park, N. Dak., were examined for the Office of Indian Affairs by the Survey in order to differentiate between the mineral and nonmineral lands as a basis for allotments and sales. The work in the Flathead Reservation was begun by the Survey during the field season of 1911, and continued during the field seasons of 1912 and 1913. The examinations in the Colville Indian Reservation were begun in 1912 and completed in 1913. The examination of the lands in the Shoshone Reservation was completed in 1913. The work in the reservations during 1913 resulted in the following classifications, all of which were promulgated during the fiscal year 1914:

*Metalliferous classifications made during the fiscal year 1914, in acres.*

State.	Mineral.	Nonmineral.	Total.
Idaho.....	.....	10,045	10,045
Montana.....	3,769	279,104	282,873
North Dakota.....	.....	779	779
Oregon.....	.....	1,193,033	1,193,033
Washington.....	143,284	774,191	917,475
Wyoming.....	.....	1,500,000	1,500,000
	147,053	3,757,152	3,904,205

HYDROGRAPHIC CLASSIFICATIONS.

WATER POWER.

*Withdrawals and restorations.*—The classification of the public lands with relation to their value in connection with water power was continued during the year, the withdrawals being made under the authority conferred by the two acts of June 25, 1910 (36 Stat., 847; 36 Stat., 858), and the act of August 24, 1912 (37 Stat., 497). On

July 1, 1913, the area included in outstanding withdrawals was 1,898,405 acres. During the year 183,612 acres additional were withdrawn and 90,400 acres previously included in power-site reserves were restored to the public domain. On June 30, 1914, the total area withdrawn in connection with water power was 1,991,617 acres.

The following table shows the action taken during the year and the areas outstanding, classified by States:

*Power sites withdrawn, restored to entry, and outstanding, in acres.*

State.	Outstand- ing July 1, 1913.	Withdrawn during fiscal year 1914.	Restored to entry during fiscal year 1914.	Outstand- ing June 30, 1914.
Alabama.....		120		120
Arkansas.....	17,704			17,704
Arizona.....	187,231	3,200		190,431
California.....	222,391	9,343	8,965	222,769
Colorado.....	254,620	15,930	160	270,390
Idaho.....	291,921	15,614	34,776	272,759
Minnesota.....	10,722	298		11,020
Montana.....	149,900	32,451	25,310	157,041
Nebraska.....		761		761
Nevada.....	15,667	3,420		19,087
New Mexico.....	13,577			13,577
Oregon.....	195,665	73,360	2,315	266,710
Utah.....	376,515	6,295	4,663	378,147
Washington.....	99,498	10,530	12,491	97,537
Wyoming.....	62,994	12,290	1,720	73,564
	1,898,405	183,612	90,400	1,991,617

*Applications for reclassification.*—At the beginning of the fiscal year 19 applications for the reclassification of lands included in power-site reserves were awaiting action and during the year 46 were received. Out of this total of 65 cases action was taken on 52, leaving 13 pending at the close of the year.

*Right of way applications.*—Departmental regulations of January 6, 1913, under the act of Congress approved March 4, 1911 (36 Stat., 1253, 1254), and of March 1, 1913, under the act of Congress approved February 15, 1901 (31 Stat., 790), charge the Geological Survey with important administrative duties in connection with applications for rights of way over the public lands for purposes relating to the development of water power. Such applications when received in proper form at the General Land Office are now forwarded to the Survey for consideration of such matters as relative priority of applications, incompatibility of works, relative beneficial utilization of resources, and the engineering and economic features involved in the applications and permits. If the approval of an application is found to be compatible with the public interest, a draft of agreement is prepared setting forth terms on which the use of the desired right of way is to be conditioned, and a report is made on the circumstances in the case.

In addition to applications for rights of way for hydroelectric development a large number of applications for rights of way of

other types are referred to the Geological Survey for consideration and report. These embrace applications for rights of way for railroads under the acts of March 3, 1875 (18 Stat., 482), and March 2, 1899 (30 Stat., 990), affecting public lands and Indian reservations, respectively, on which report is made as to whether or not the construction of the railroad will interfere with power or irrigation development on streams in the vicinity of the right of way; applications for rights of way under the act of March 3, 1891 (26 Stat., 1095), for irrigation uses on which report is made as to interference with power development, the feasibility of the project, and other features; applications for rights of way across national forests for mining, milling, and municipal purposes under the act of February 1, 1905 (33 Stat., 628); and a variety of miscellaneous applications for domestic, municipal, mining, and railroad water supply. The number of each type received and the action taken thereon is indicated in the following table:

Applications for rights of way.

Classes.	Pending July 1, 1913.	Fiscal year July 1, 1913, to June 30, 1914.		
		Received.	Acted on.	Pending June 30, 1914.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 13, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 404), etc.....	19	119	108	30
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), May 11, 1898 (30 Stat., 404), etc.....	18	237	239	16
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.....	21	63	31	53
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 11, 1898 (30 Stat., 404), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.....		84	73	11
	58	503	451	110

The first application received from the Secretary's office was dated Oct. 11, 1909; from the General Land Office Nov. 11, 1909; from the Office of Indian Affairs Dec. 23, 1909.

IRRIGATION.

*Reservoir withdrawals.*—A number of reservoir sites, principally valuable for the storage of water for irrigation, have been investigated by the Geological Survey, and the land included therein withdrawn from entry on its recommendation. The area included in such withdrawals at the close of the fiscal year is shown in the following table:

*Reservoir sites restored to entry during fiscal year 1914, in acres.*

State.	Outstanding July 1, 1913.	Restora- tions during fiscal year.	Outstanding June 30, 1914.
Arizona.....	23,040	.....	23,040
Montana.....	15,640	.....	15,640
North Dakota.....	1,569	.....	1,569
Oregon.....	10,619	.....	10,619
South Dakota.....	8,542	.....	8,542
Washington.....	36,083	140	35,943
	95,493	140	95,353

*Carey Act segregations.*—During the year 19 proposed segregation lists under the Carey Act were received for report as to available water supply, general feasibility of plan of reclamation, and mineral character of the lands, and reports on all these lists had been submitted before the fiscal year closed.

*Irrigation projects.*—The Geological Survey, by the instructions of the Secretary of the Interior, dated March 15, 1913, furnishes to the Commissioner of the General Land Office all information at hand relative to the water supply available and the feasibility of irrigation projects, water rights or shares in which are presented as evidence of compliance with the requirements of the desert-land act. Such cases to the number of 219 were received during the year, and 15 were carried over from the preceding year. Of these, 115 cases were reported on and 119 were pending June 30, 1914.

#### ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), and June 13, 1912 (37 Stat., 132), was continued during the year, the provisions of these acts having now been extended to 12 western public-land States. Designations during the fiscal year have added a large acreage to that previously classified, the additional lands having been included as a result of investigations of surface and underground water supplies. The table following summarizes the work of the year:

*Enlarged-homestead designations and cancellations, fiscal year 1914, in acres.*

State.	Outstanding July 1, 1913.	Designa- tions dur- ing fiscal year 1914.	Cancell- ations dur- ing fiscal year 1914.	Outstand- ing June 30, 1914.
Arizona.....	26,959,779	588,311	3,018,054	24,530,036
California.....	1,763	818,713	.....	850,506
Colorado.....	20,382,717	3,963,548	52,968	24,293,297
Idaho:				
Sections 1-5 only.....	5,542,238	1,683,841	32,859	7,193,220
Section 6.....	14,654	38,662	.....	53,316
Total.....	5,556,892	1,722,503	32,859	7,246,536
Montana.....	32,247,483	10,835,795	86,207	42,997,071
Nevada.....	49,503,509	349,365	3,548,941	46,303,933
New Mexico.....	17,907,739	1,330,532	192,275	19,045,996
North Dakota.....	130,502	8,252,142	2,880	8,379,764
Oregon.....	11,517,936	4,327,189	975,300	14,869,825
Utah:				
Sections 1-5 only.....	7,065,989	68,548	168,228	6,966,309
Section 6.....	1,200,686	16,540	120	1,217,106
Total.....	8,266,675	85,088	168,348	8,183,415
Washington.....	3,408,897	474,784	222,828	3,660,853
Wyoming.....	17,620,773	324,319	24,596	17,920,496
	193,504,695	33,102,289	8,325,256	218,281,728

The general provisions of the acts, which apply in all 12 States, permit the entry by one person of 320 acres of “nonmineral, non-irrigable, unreserved, and unappropriated surveyed public lands which do not contain merchantable timber.” As a prerequisite to the allowance of such entry, the land must have been designated by the Secretary of the Interior as not being, in his opinion, “susceptible of successful irrigation at a reasonable cost from any known source of water supply.” Under the provisions of section 6 of the acts of February 19, 1909, and June 17, 1910, applicable in Utah and Idaho, the Secretary may further designate lands which do not have upon them “such a sufficient supply of water suitable for domestic purposes as would make continuous residence upon the lands possible,” and entrymen upon such lands are relieved of the necessity of residence.

Designations under the enlarged-homestead act are made either in large compact areas, as a result of field investigations covering districts of considerable size, or in small units, as a result of the requests of prospective entrymen. These requests are referred to as enlarged-homestead petitions, and because of the fact that the larger areas of land to which the acts are believed to be applicable have already been designated, the record of the year shows a large increase in the number of petitions received. The handling of the largely increased number of applications of this character has been made possible only by the adoption of additional labor-saving devices, the substitution of form post cards for typewritten letters, and the standardization



of office methods. The following table indicates the disposition made of petitions received during the year:

*Action on petitions under enlarged-homestead acts during fiscal year 1914.*

State.	Pending July 31, 1913.	Re- ceived.	Action taken.			Total acted on.	Pending June 30, 1914.
			All desig- nated.	Part des- ignated.	Refused.		
Arizona.....	6	104	81	10	11	102	8
California.....	4	213	121	7	23	151	66
Colorado.....	69	203	172	22	24	218	54
Idaho.....	305	1,049	695	49	129	873	481
Montana.....	195	1,733	1,149	93	67	1,309	619
Nevada.....		6	5	1		6	
New Mexico.....	43	143	115	10	19	144	42
North Dakota.....	604	1,171	1,578	47	83	1,708	67
Oregon.....	42	715	543	40	38	621	136
South Dakota.....		6			6	6	
Utah.....	35	101	49	4	4	57	79
Washington.....	15	128	95	2	7	104	39
Wyoming.....	23	137	62	12	26	100	66
	1,347	5,709	4,665	297	437	5,399	1,657

A set of maps of the States affected, showing areas designated under the enlarged-homestead acts and the status of designations June 30, 1914, has been printed.

**PUBLIC WATER RESERVES.**

As information has become available, recommendations have continued to be made for the creation of public water reserves, in order that important springs and sources of stock water on the desert and semiarid range lands may remain accessible to the public. Additions amounting to 74,814 acres have been made during the year to reserves of this type. The action taken is summarized in the following table:

*Public water reserves withdrawn and restored, fiscal year 1914, in acres.*

State.	Outstand- ing July 1, 1913.	Withdrawn during fis- cal year 1914.	Restored to entry during fis- cal year 1914.	Outstand- ing June 30, 1914.
Arizona.....	1,200			1,200
California.....	94	43,430		43,524
Colorado.....		480		480
New Mexico.....		1,440		1,440
Oregon.....		2,500		2,500
Utah.....	26,303	6,564	160	32,707
Wyoming.....	62,979	20,400	1,468	81,911
	90,576	74,814	1,628	163,762

**PUBLICATION BRANCH.****BOOK-PUBLICATION DIVISION.****SECTION OF TEXTS.**

During the year 47,751 pages of manuscript were edited and prepared for printing and proof sheets for 16,786 final printed pages were read and corrected. This work involved the handling of 4,574 galley proofs and 28,202 page proofs. The corresponding figures for 1912-13 were 38,191 pages of manuscript, 22,395 final printed pages, 4,877 galley proofs, and 38,864 page proofs. Indexes were prepared for 56 publications, covering 11,143 pages; the figures for the previous year were 55 publications and 14,942 pages. The list given on pages 13-31 shows the number, scope, and character of the reports issued during the year.

At the close of the fiscal year seven persons were employed in this section. The water-resources branch has continued to render special assistance in copy preparing and proof reading.

**SECTION OF ILLUSTRATIONS.**

The number of illustrations prepared was 3,068 and included 384 maps, 429 photographs prepared for reproduction, 490 diagrams and sections, 4 landscapes, 1,499 paleontologic drawings and photographs, and 262 miscellaneous.

The processes used for the reproduction of these illustrations, and the number reproduced by each process, were as follows: Chromolithography and photolithography, 261 subjects; halftone engraving, 928 subjects; zinc etching, 752 subjects; wax engraving, 50 subjects; cuts already engraved, 57 subjects. Proofs to the number of 2,179 were received and compared critically. Of these 287 were revises. The finished work representing all the illustrations furnished by contractors was examined. Engraved cuts to the number of 155 were reused during the year and electrotypes of 72 cuts were furnished to outside applicants.

At the close of the year material for illustrating 27 reports is on hand.

As in previous years, a cost record has been maintained covering the work prepared. This record shows from month to month a satisfactory earning capacity of the force. The personnel of the section at the close of the year consists of the chief of the section, 10 draftsmen (8 permanently employed and 2 temporarily), 1 under clerk, and 1 assistant map printer.

**SECTION OF DISTRIBUTION.**

The section of distribution received during the year 171 new books, 42 reprinted books, 5 geologic folios, 10 geologic maps, 86 new topographic maps, 6 revised maps, 11 photolithographs, and 190 reprints

of maps, a total of 521 publications. The total of all editions received was 475,925 books, 23,070 geologic folios, and 929,446 maps, a grand total of 1,428,441.

There were distributed 586,514 books, 64,543 folios, and 454,654 maps (including 338,253 maps, 59,075 folios, and 197 books sold), a total of 1,105,711, a notable increase in distribution of book publications, a decrease in sale of topographic maps, due to increase in price, and an increase in number of folios, sold at low price because of damage by fire.

The total amount received and turned into the Treasury as the result of sales of publications was \$28,596.71. The proceeds of sales of topographic and geologic maps was \$25,035.01, of topographic and geologic folios, \$3,225.95, and of books \$335.75. The amounts received from map and folio sales are essentially the same as for the previous year.

Sixteen persons were employed in this section during the year, and 90,930 letters were received and answered during that period.

#### DIVISION OF MAP EDITING.

##### SECTION OF GEOLOGIC MAPS.

This section continued in charge of George W. Stose, geologist, who directed the publication of the maps and illustrations of the geologic folios and critically reviewed all geologic maps intended for publication in other reports of the Survey.

Five folios (Nos. 188 to 192, inclusive), which are included in the list on pages 29–30, were published during the year, and one folio comprising the text and economic-geology maps of three folios (Placerville, Sacramento, and Jackson) now out of print was published as Folio Reprint 3, 5, and 11. The maps for the Belleville-Breese (Ill.), Columbus (Ohio); San Francisco (Cal.), Philipsburg (Mont.), and Van Horn (Tex.) folios were printed, and the folios will be published as soon as the descriptive texts can be printed. The maps of the Bisbee (Ariz.) folio have been reprinted and the folio will soon be reprinted, with slight revision and additions. The reprint of the Joplin folio was nearly completed, and the reprint of the Ann Arbor folio, with extensive revision, was well advanced.

The folios in course of publication and in preparation in this section are arranged in order of progress in the following list:

- Joplin, Mo. (reprint) (No. 148).
- Bisbee, Ariz. (reprint) (No. 112).
- San Francisco, Cal. (five quadrangles) (No. 193).
- Van Horn, Tex. (No. 194).
- Belleville-Breese, Ill. (No. 195).
- Philipsburg, Mont. (No. 196).
- Columbus, Ohio (No. 197).

Ann Arbor, Mich. (reprint) (No. 155).  
Eureka Springs-Harrison, Ark.  
Castle Rock, Colo.  
Silver City. N. Mex.  
Galena-Elizabeth, Ill.  
Colorado Springs, Colo.  
Minneapolis-St. Paul, Minn. (four quadrangles).  
Tolchester, Md.  
Detroit, Mich. (five quadrangles).  
Deming, N. Mex.  
Herman-Morris, Minn. (four quadrangles).  
Montevallo-Columbiana, Ala.  
Bessemer-Vandiver, Ala.  
Elkton-Wilmington, Md.-Del.  
Bellefonte, Pa.  
Sheffield-Sandisfield, Mass.  
Pittsfield-Becket, Mass.  
Cleveland, Ohio (three quadrangles).  
Colchester-Macomb, Ill.  
Leavenworth-Smithville, Kans.

Two draftsmen in addition to the geologist in charge are employed in the section.

SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 194 atlas sheets and maps of special areas were on hand for publication. Of these, 1 map was withdrawn for additional field work and 5 incomplete atlas sheets have been combined each with an adjoining atlas sheet, leaving 188. The accessions during the year were 89, making a total of 277, of which 94 (89 new engraved sheets, 1 revised and reengraved sheet, and 4 three-color photolithographs) have been published. In addition to these maps 1 sheet has been revised, corrected, and published in a new edition, and 7 photolithographs of State maps have been published, making the total number of separate map publications for the year 102. The following statement shows the comparative status of map editing and publication on June 30 for four years past:

*Progress of map publication for four years ended June 30, 1914.*

	1914	1913	1912	1911
Published during the year.....	102	101	114	88
In process of engraving.....	69	89	65	56
Unedited.....	114	105	102	95

The manuscripts edited during the year comprise 75 topographic atlas sheets and other maps prepared for engraving, 4 detailed topographic sheets for photolithography in three colors, 3 State maps on scale of 1:500,000, 148 sheets of plans and profiles of 17 rivers, corrections for 138 engraved maps about to be reprinted, and 242 maps

for illustration of 42 Geological Survey reports. The proof read comprises 89 new topographic maps, corrections to 54 old maps, the 9-sheet contour map of the United States, and 2 maps reproduced under contract. The index maps for 17 circulars of the series 9-323 were revised during the year and all printed but 3, which are now in press. Revised lists of topographic maps were prepared as copy for a new edition of the pamphlet "Topographic maps and folios and geologic folios."

Six men were employed in this work continuously, except that the editor of topographic maps was engaged in topographic field work for two months.

#### DIVISION OF ENGRAVING AND PRINTING.

##### MAPS AND FOLIOS.

During the fiscal year 89 topographic maps were engraved and printed; 2 topographic atlas sheets were corrected after field revision and new editions printed; and 7 State maps, scale 1:500,000, and 4 three-color topographic maps were photolithographed and printed during the year, making the total number of new maps and new editions printed 102.

The work on hand July 1, 1913, involving extensive corrections to maps of areas in Alaska and also the United States 9-sheet map, was completed during the present year.

Corrections were engraved upon the plates of 154 sheets (including 138 for reprinting editions and 16 for various purposes). Of those corrected for reprinting and including new maps (engraved and photolithographed) 301 different editions were printed and delivered to the map room. This is a decrease of 77 editions and 287,994 copies of regular office maps from the previous year.

Five new geologic folios and one reprint folio were published during the year, which is two more than the number published in the preceding year, and of the number published this year, two are double folios. Octavo editions of two of this number and of one folio reported last year were published during the present year. Editions and partial editions of folios and octavos amounting to 28,230 copies were printed and delivered. This is an increase of 9,684 copies during the year.

##### CONTRACT ENGRAVING AND PRINTING.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual report of the Isthmian Canal Commission; annual report of the Chief of Engineers United States Army; annual report of the Commissioner General of Immigration; annual report of the War Department, volume 2; annual report of the Governor of Hawaii; annual report of the Superintendent of the Coast and Geodetic Survey; annual report of

the Commissioner of Indian Affairs; Census report, population, volumes 1-3; report of the Commissioner of Fisheries, 1911, and special papers; Census report, Agriculture, Part I; special publication No. 16, Coast and Geodetic Survey; technical paper No. 50, Bureau of Mines; Report on lumber industry, Part II, map of Idaho; Report on education of the natives of Alaska; Ordnance pamphlet No. 132, Navy Department; hearings, Paint Creek mining district, W. Va., Part II; report of the Commissioner of Corporations on water-power development in the United States; report of the Commissioner of Corporations on the lumber industry, Part III; report of the Commissioner of Corporations on transportation by water in the United States, Part III, Water terminals; Bulletin No. 54, Department of Agriculture; Bulletin No. 114, Department of Agriculture; American Ephemeris and Nautical Almanac, 1917; Statistical atlas, 1910; Bureau of the Census; separate chapters from Census report, volume 5, Agriculture, general report and analysis; Physical investigations of New York lakes, Bureau of Fisheries; 11 House documents; illustrations for Geological Survey Bulletins 528, 531-F, 531-I, 536, 538, 541-A, 541-D, 541-F, 541-H, 546, 547, 549, 550, 551, 552, 575, 579, Water-Supply papers 305, 335, 341, 358, and The stone industry in 1912, advance chapter from Mineral Resources. In addition, the following separate illustrations were printed and delivered to the Government Printing Office: Diagrams of two bird reservations, one national monument, and two reservations for use of natives of Alaska; panoramic view of Crater Lake National Park; Ringlemann's scale for grading the density of smoke; map of the United States by counties; map showing origin of the scenic features of Glacier National Park; relief map of Yosemite National Park; map showing glaciers of Mount Rainier National Park; map showing glaciers of Glacier National Park; cross-section paper (General Land Office); maps of 48 States; forest atlas conventional township sketching (Forest Service).

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 17 national forests, 7 fire folder and tourist maps, 12 proclamation diagrams of national forests, 13 enlargements of field sheets, map of national forests, district No. 2, maps of national forests, districts Nos. 3 and 5, 9 maps of rivers showing hydroelectric development, and other miscellaneous work; for the General Land Office, 1,516 township plats, 753 mineral and homestead plats, two State maps showing homesteads, and map of Powell town site; for the Office of Indian Affairs, maps of three Indian reservations and lookout station protractor. Work was also done for the Reclamation Service, Interstate Commerce Commission, District of Columbia, Department of Justice, Bureau of Mines, Isthmian Canal Commission, Navy Department



(Bureau of Steam Engineering), Post Office Department, Army Service Schools, Engineer School (United States Army), Coast Artillery School, United States National Museum, Bureau of Standards, United States and Canada Boundary Survey, Alaska Boundary Survey, Army War College, Bureau of Soils, Alaskan Engineering Commission, Department of the Interior, and Weather Bureau.

In addition to the above, a large amount of miscellaneous work was done for other divisions and branches of the Survey. This work for various branches of the Government, including work done for other divisions and branches of the Survey, amounted to about \$65,000, for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for the city of Rochester, Columbia Planograph Co., Julius Bjen Co., Edward T. Miller Co., Lord Baltimore Press, Bailey Willis (Argentine Government), Norris Peters Co., Isaac Markens, Geo. W. Bromley & Co., Harvard Cooperative Society, and Stecher Lithographic Co., and the money received in payment for the work, amounting to about \$100, was turned into the Treasury of the United States to be credited to miscellaneous receipts. Under cooperative agreements, transfer impressions were furnished without charge to the State surveys of New York, West Virginia, Kentucky, Illinois, and Maryland.

Of contract and miscellaneous printing of all kinds, the total number of copies delivered was 1,792,420, which required approximately 2,150,000 printings. The total number of copies printed, including topographic maps and geologic folios, was 2,758,893, requiring approximately 7,300,000 impressions. On requisition of the Government Printing Office, 296 transfer impressions were made and shipped to contracting printers.

#### **INSTRUMENT SHOP.**

The work of the instrument shop consisted of repairs on surveying, drafting, engraving, stream-gaging, and other instruments both for the Geological Survey and the Reclamation Service and General Land Office, and the making of copper plates and electrotypes. More than 2,400 repairs and overhauls were made, 75,966 square inches of new copper plates were made, 4,284 square inches were resurfaced, and 1,428 square inches of electrotypes were made.

#### **PHOTOGRAPHIC LABORATORY.**

The output of the photographic laboratory included 16,123 negatives, of which 9,069 were dry, 3,568 were wet, 4,355 were photolithographic, and 846 were paper; 3,539 zinc plates; 258 zinc etchings; 293 celluloids; and 27,874 prints, of which 14,952 were maps and diagrams and 22,922 were photographs for illustrations.



**ADMINISTRATIVE BRANCH.****EXECUTIVE DIVISION.**

The work in the executive division was of the same scope as in other years.

*Mails, files, and records.*—During the year 146,903 pieces of mail were opened and referred. Of this number, 2,387 were registered. In addition, 108,599 letters were received direct by the other divisions—a total of 255,502 for the Survey, an increase of 8 per cent compared with the total number of letters received during the fiscal year 1913.

Of the letters opened in this division, 26,691 contained remittances for Survey publications, a decrease of 5 per cent compared with the number of similar letters received during the last fiscal year, and the amount of money received, \$29,805.73, shows a decrease of \$254.47 compared with that received during 1913.

The recording, referring, and filing of correspondence required practically the entire services of five clerks. The number of letters mailed through the division was 121,401, an increase of about 21.5 per cent over the preceding year. This number does not include the outgoing registered mail, which numbered 15,995 pieces, or 228,593 pieces of letter mail sent direct from the other divisions—a total of 365,989 for the Survey, an increase of 20 per cent over the total number sent in 1913.

*Personnel.*—The roll of those holding Secretary's appointments numbered at the close of the fiscal year 891, compared with 893 at the close of the fiscal year 1913. The total number of changes in the personnel for the year was 604, which included original appointments, separations, promotions, extensions, and changes of status of every description. Of these, 162 were new appointments, 164 were separations, 231 were promotions, and 3 were reductions.

During the year 12,984 days of annual leave and 2,138 days of sick leave were granted, being 58 per cent of the amount of annual leave and 10 per cent of the amount of sick leave which it is permissible to grant under the law; also there were granted 3,460 days of leave without pay.

*Express and freight.*—During the year 4,187 pieces of freight and express were handled, of which 1,047 were outgoing and 3,140 were incoming. The number of pieces of freight and express handled shows an increase of about 7 per cent over the number handled during the fiscal year 1913. There were 441 transportation accounts checked during the year.

*Stationery.*—There were 4,874 requisitions filled from stock in the stationery room during the fiscal year 1914.

DIVISION OF ACCOUNTS.

A condensed statement covering the financial transactions of the fiscal year is given below, including disbursements up to September 30. The unexpended balances of that date largely represent outstanding obligations.

*Amounts appropriated for and expended by the United States Geological Survey pertaining to the fiscal year ended June 30, 1914.*

Title of appropriation.	Appropriation.	Repayments.	Available.	Disbursements.	Balance.
Salaries, office of Director.....	\$35,340.00	.....	\$35,340.00	\$35,150.50	\$189.50
Salaries, scientific assistants.....	29,900.00	.....	29,900.00	29,872.18	27.82
Skilled laborers, etc.....	20,000.00	.....	20,000.00	19,994.16	5.84
Gaging streams, etc.....	150,000.00	\$26,261.38	176,261.38	175,058.45	1,202.93
Chemical and physical researches.....	40,000.00	91.60	40,091.60	37,191.71	2,899.89
Preparation of illustrations.....	18,280.00	.....	18,280.00	18,278.01	1.99
Mineral resources of United States.....	75,000.00	219.10	75,219.10	74,610.05	609.05
Geologic maps of United States.....	110,000.00	55,777.50	165,777.50	159,443.45	6,334.05
Books for the library.....	2,000.00	.....	2,000.00	1,973.92	26.08
Topographic surveys.....	350,000.00	4,490.12	354,490.12	351,489.67	3,000.45
Geologic surveys.....	300,000.00	49,381.20	349,381.20	340,867.38	8,513.82
Mineral resources of Alaska.....	100,000.00	316.28	100,316.28	98,340.05	1,976.23
Surveying national forests.....	75,000.00	.....	75,000.00	74,188.28	811.72
Replacing articles destroyed by fire....	50,000.00	.....	50,000.00	45,525.68	4,474.32
Reimbursements for loss of personal property.....	80.16	.....	80.16	80.16	.....
	1,355,600.16	136,537.18	1,492,137.34	1,462,063.65	30,073.69

The following table gives the classified expenditures by the Survey for the fiscal year:

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1914.

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persons.	Subsistence and care of animals.	Communication service.	Printing, engraving, lithographing, etc.	Furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials.	Stationery, drafting, etc., supplies.
Salaries, office of the Director	\$35,150.50	\$35,150.50										
Salaries, scientific assistants	29,872.18	29,872.18										
Skilled laborers, etc.	19,994.16	19,994.16										
Gaging streams, etc.	175,058.45	127,462.14	\$15,764.92	\$1,099.96	\$8,135.25	\$588.57	\$627.84	\$2,063.12		\$1,646.14	\$2,631.41	\$1,479.28
Chemical and physical researches	37,191.71	29,638.15	1,740.82	251.50	1,041.86	22.25	67.85	114.09	\$264.00	207.97	147.10	585.99
Preparation of illustrations	18,278.01	17,275.39	14.05	2.10	11.50		14.42	728.97		16.50	2.92	91.09
Mineral resources United States	74,610.05	66,934.50	2,492.63	138.66	1,675.61	10.10	665.07	575.32		544.19	238.20	468.32
Geologic maps	159,443.45	124,335.19	145.06	33.57	130.80		70.69	1,282.66	2,072.13	1,680.47	5,053.62	19,331.15
Books for the library	1,973.92			8.09								
Topographic surveys	351,489.67	237,824.83	27,221.05	3,549.62	41,962.58	10,962.27	809.58	3,916.15		1,504.30	1,450.03	1,048.99
Geologic surveys	340,867.38	272,704.19	22,019.03	3,644.35	15,601.87	5,437.42	596.68	5,193.01	124.80	2,320.47	417.84	1,364.60
Mineral resources of Alaska	98,340.05	62,765.22	14,278.69	3,374.96	3,817.00	303.18	111.50	997.61		415.82	292.80	681.02
Surveying national forests	74,188.28	48,974.56	3,852.40	647.01	9,723.56	4,588.62	57.25	627.48		424.65	336.35	192.76
Replacing articles destroyed by fire	45,525.68	4,126.58	56.70	14.34	48.60	.15	.82	39.38		47.26	1,660.41	12,873.05
Reimbursements for loss of personal property	80.16											
	1,462,063.65	1,077,057.59	87,585.35	12,764.16	82,148.03	21,912.56	3,021.70	15,537.79	2,460.93	8,807.77	12,231.28	38,116.25

Appropriation.	Fuel.	Mechanics, engineer's, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forage and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Awards for losses.	Rent.
Gaging streams, etc.	\$134.28	\$79.84	\$15.43	\$323.00	\$289.99	\$375.00	\$6.95	\$78.85	\$9,516.48			\$2,740.00
Chemical and physical researches	250.94	13.48	3.48	2.75	97.37	156.09	.48	.75	2,412.29			172.50
Preparation of illustrations								3.11	117.96			
Mineral resources United States	1.83	2.38	3.30		12.42	1.42		9.13	406.12			430.85
Geologic maps	433.14	359.70	430.36	22.56				262.83	3,799.52			
Books for the library									1,905.83			
Topographic surveys	175.65	139.86	51.43	23.85	4,196.80	1,086.19	.70	23.57	13,809.56	\$1,590.23		171.83
Geologic surveys	131.40	77.60	55.33	43.12	1,899.26	4,978.92	27.25	197.98	4,051.29			11.00
Mineral resources of Alaska	338.83	23.42	17.38	30.70	863.23	3,404.55	81.99	48.71	6,433.47			
Surveying national forests	40.05	11.30	8.75	94.45	1,898.86	87.83	2.15	4.40	2,553.85			62.00
Replacing articles destroyed by fire		18.30	.97					2.95	26,636.17			
Reimbursements for loss of personal property											\$80.16	
	1,536.09	695.88	580.40	540.43	9,257.93	10,090.00	119.52	632.28	71,702.54	1,590.23	80.16	3,588.18

## LIBRARY.

The growth of the library has continued at about the usual rate. In all, 13,229 publications were received, including books, pamphlets, periodicals, and maps. This number comprises the gifts, exchanges, and purchases. Practically all the important new literature of geology has been obtained and such other publications as are required in the Survey work. From the exchanges a number of valuable books and papers have been received; and the library is indebted to many members of the Survey, besides other friends, for generous gifts of books and separates.

Current receipts are catalogued to date, and in addition steady progress has been made in completely cataloguing certain of the older sections for which only temporary entries were in the catalogue. These sections are as follows: Geological surveys of Switzerland and Tasmania completed; geological surveys of Italy, Belgium, Cape of Good Hope, Egypt, Natal, Portugal, and Spain; Academy of Sciences, St. Petersburg, Mémoires, seventh series; serials (periodicals and scientific transactions) of Central America, Mexico, South America, and the West Indies; miscellaneous periodicals (over 52 sets); and sections of general geology (elementary and older books), dynamic geology, structural geology, glaciers, historical geology, and petroleum. In all, 6,443 books, pamphlets, and maps were catalogued, and 9,548 cards were added to the catalogue, and 1,042 titles were furnished to the Library of Congress for printing.

A large number of interlibrary loans were made, and many students and specialists have availed themselves of the library facilities. The number of readers in the library during the year was 7,943; 8,694 books and maps were lent for use outside. Some progress has been made in cataloguing the older maps in the library, and Henry Gannett has continued to supervise the map collection and to devote a portion of his time to the correspondence which calls for information from the maps.

The bibliography of North American geology for 1912 was completed and published as Bulletin 545. The bibliography for 1913 has been completed and is in press as Bulletin 584.



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**DEPARTMENT OF THE INTERIOR**

**FRANKLIN K. LANE, Secretary**

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**UNITED STATES GEOLOGICAL SURVEY**

**GEORGE OTIS SMITH, Director**

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**THIRTY-SIXTH ANNUAL REPORT**

**OF THE**

**DIRECTOR OF THE UNITED STATES  
GEOLOGICAL SURVEY**

**TO THE**

**SECRETARY OF THE INTERIOR**

**FOR THE FISCAL YEAR**

**ENDED JUNE 30**

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# THIRTY-SIXTH ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY.

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GEORGE OTIS SMITH, *Director*.

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The appropriations for the work of the United States Geological Survey for the fiscal year 1914-15 comprised items amounting to \$1,620,520. The plan of operations was approved by the Secretary of the Interior, and a detailed statement of the work of the several branches and divisions of the Survey is presented on later pages of this report.

## SPECIAL FEATURES.

### A LARGER PUBLIC SERVICE.

In the last decade the United States Geological Survey has largely increased its return to the public, both in amount and in variety of service rendered. The statement was made in this report a year ago that never before had the general public been in closer touch with this Survey or made larger use of the results of its scientific investigations. The recognition by citizens generally that the Geological Survey is a bureau of information as well as a field service has gradually placed upon it a large burden of work as well as of responsibility. The amount of correspondence involved in performing this public duty may be indicated by the fact that approximately 50,000 letters of inquiry were handled in the different scientific branches of the Survey last year. The scope of these inquiries is not less noteworthy, for they range from requests for information concerning the geology of every part of the United States or the ~~water~~ supply, both underground and surface, of as widely separated regions as Alaska and Florida, or for engineering data on ~~areas in every~~ State in the Union, to inquiries regarding the natural resources of foreign countries, especially those of Central and South America.

The changes in the world's trade in metals and other mineral products during the last year brought to the Geological Survey a new opportunity for special service. The inquiries concerning possible sources of this or that mineral product began early in August, and the Secretary of the Interior gave to the public an interview outlining the expected developments in the mineral industry. His

statement was followed by special press bulletins issued by the Survey on the more important subjects. In September, however, the demand for authoritative information had become so lively that a bulletin—"Our mineral reserves" (Bulletin 599)—was quickly prepared and issued without delay. In this publication the whole subject of the country's ability to meet the emergency demands for minerals was summarized and the Survey offered to serve as an agent in bringing consumer and producer into touch with each other. This new function of acting as "central" to the mineral industry proved popular, a large volume of special correspondence developed, and a gratifying use was made of the Geological Survey's list of mineral producers and of the specific information in the possession of the Federal geologists regarding practically every type of mineral deposit in the country. It is believed that this correspondence has been of material advantage to consumers and producers alike—the users of mineral products who were formerly dependent upon foreign sources of supply and the mine operators who have learned of new markets for their output.

The preparation of this special information to meet a new public demand, together with the continued task of replying to requests for specific information, has resulted in placing fresh emphasis on this phase of the work of the Geological Survey. The rendering of such service is in itself instructive to those charged with the duty, and the Survey staff has acquired a keener realization of the need not only of giving the facts to the public, but also of making those facts intelligible and useful to the citizen who lacks professional training in geology or engineering. Two obligations are thus laid upon the Government scientist—first, that of making his investigations more and more exact in method and more definite in result; second, that of transmitting the product of his investigations in a form to meet the needs of not only his professional associates but of the general public. Most scientists in the public service should aspire to the translation of their own reports into the language of the people.

The Survey as the center of public information concerning the geology of the United States bears an educational obligation to the public. It has so far, in part, neglected its opportunity as well as its duty as an investigative branch of the Government to furnish popular information of an instructive type regarding this most enlightening science. In recognition of this educational responsibility and of the importance of making its work more generally intelligible and useful to the private citizen who has not been geologically educated, several members of the Survey have of late given more attention both to the simplification of the language of the professional publications and to *the preparation* of reports that are popularly descriptive and instruc-

tive, yet also exact and efficient as vehicles for professional discussion or for the announcement of geologic discoveries.

Conforming to this growing conviction, the Survey has printed on the backs of several of its topographic maps nontechnical descriptions of the physical features of the area mapped and of their origin. The evident appreciation by the general public of such explanations of the geologic features as shown by the increased demand for the maps has encouraged the extension of the practice. Accordingly, after the publication of such matter for the map of the Crater Lake National Park, Oregon, the Bright Angel area, in the Grand Canyon of Arizona, has similarly been described, and descriptions for other areas, including the Delaware Water Gap, in Pennsylvania and New Jersey, are now being prepared. This work is a by-product of the geologic mapping and therefore involves comparatively little expense, but it adds greatly to the general interest and educational value of the topographic maps.

Survey geologists have prepared guides covering the points of scenic or unusual geologic interest in the Glacier National Park and in the Mount Rainier National Park, which were published as small brochures for distribution from the office of the Secretary of the Interior, and now the compilation of more elaborate and comprehensive accounts of the geography and the origin of the principal geologic features in several of the national parks has been undertaken for publication as bulletins of the Survey. "The Glacier National Park, a popular guide to its geology and scenery," by M. R. Campbell, has been issued within the year as Bulletin 600. An illustrated guide containing descriptions, with maps, of the geology and of the origin of the striking physical features in the Yosemite Valley of California, with a study of the glaciation, is now being prepared in popular language by F. E. Matthes and F. C. Calkins and will probably be published at an early date as a bulletin. The Mesa Verde National Forest is to be similarly described and illustrated by A. J. Collier, the preparation of whose matter has, however, been necessarily interrupted by work in land classification.

A more ambitious project was undertaken this year. Mindful of the great numbers of educated and intelligent tourists, both American and foreign, who were likely to visit the Pacific coast during the exposition year, and painfully aware of the lack of satisfactory guidebook descriptions, with adequate and accurate maps, covering the physical features of the regions traversed by the greater number of the exposition visitors, the Survey determined to give the public the benefit of a portion of the wealth of geographic and geologic information in its possession, through the publication of guidebooks to the geography, geology, mineral wealth and other natural resources, industries, and history of the regions bordering several of the trans-



continental routes. The small amount of money that could be devoted to this project without sacrifice to the public welfare in other lines of Survey work of more importance though of less popular interest made it practicable this year to undertake the preparation of only four such guides, as follows:

The Northern Pacific Route, from St. Paul to Seattle, with a side trip to the Yellowstone National Park (Bulletin 611).

The Overland Route, from Omaha to San Francisco, with a side trip to the Yellowstone National Park (Bulletin 612).

The Santa Fe Route, from Kansas City to Los Angeles, with a side trip to the Grand Canyon of the Colorado (Bulletin 613).

The Shasta Route and Coast Line, from Seattle and Los Angeles to San Francisco (Bulletin 614).

The first of these books, that describing the Overland Route, was issued in June, and the others followed in July, August, and September. These books inform the traveler concerning the great West, its features and its resources, as well as unfold to him in attractive form its fascinating geology. The method adopted is to entertain the traveler by making more interesting what he sees from the car window, to guide his eyes toward the more important or essential things within his field of vision, and then to have much that he sees explained by what is unseen in the swift passage of the train. The magnificent illustrations of the great principles of earth evolution seen along the route are used to teach some of the principles of geology; and fragments of the story of the past are narrated to enable him to interpret the present. As stated in the preface of these volumes—

The plan of the series is to present authoritative information that may enable the reader to realize adequately the scenic and material resources of the region he is traversing, to comprehend correctly the basis of its development, and above all to appreciate keenly the real value of the country he looks out upon, not as so many square miles of territory represented on the map in a railroad folder by meaningless spaces, but rather as land—real estate, if you please—varying widely in present appearance because differing largely in its history and characterized by even greater variation in values because possessing diversified natural resources. One region may be such as to afford a livelihood for only a pastoral people; another may present opportunity for intensive agriculture; still another may contain hidden stores of mineral wealth that may attract large industrial development; and taken together these varied resources afford the promise of long-continued prosperity for this or that State.

Items of interest in civic development or references to significant epochs in the record of discovery and settlement may be interspersed with explanations of mountain and valley or statements of geologic history. In a broad way, the story of the West is a unit, and every chapter should be told in order to meet fully the needs of the tourist who aims to understand all that he sees. To such a traveler-reader this series of guidebooks is addressed.

Somewhat related to the more distinctly educational reports *already* described are two bulletins—"The data of geochemistry" (Bulletin 491), by F. W. Clarke, and "Useful minerals of the United

States" (Bulletin 585), compiled by Samuel Sanford and R. W. Stone. A third edition of the former (Bulletin 616) and a revision of the latter, much enlarged by F. C. Schrader, with a glossary showing the composition and character of each mineral (Bulletin 624), are now in course of publication. The editions of these handbooks of general information on broad subjects are rapidly exhausted.

The special efforts of the last year to reach the public with these more popular publications are intended as the beginning of a movement to popularize further the results of scientific investigations. Both the opportunity and the duty of the United States Geological Survey to furnish scientific information in popular form are appreciated.

#### DEMAND FOR GEOLOGIC WORK.

Especially noteworthy among the features of the year's work is the great increase in the demands made on the Federal geologists for specific investigations of an economic nature. The requests have touched all lines in the geologic province, but most of them ask for the examination of reported discoveries of potash or nitrate salts; for the study of the ore deposits in metal-mining districts, newly discovered or old; or for the investigation of the geologic structure in many regions, with a view to the discovery of areas that may be regarded as structurally favorable for the occurrence of oil or gas pools.

The calls from many States for examinations as to the possibilities of finding oil in untested regions have been nearly as numerous as all others combined, applications for classification of public lands excepted. In this field of applied geology especially the Geological Survey is coming more and more to be regarded as the consulting geologist for the public. Many of the great oil companies, recognizing the paramount value of a knowledge of the geologic structure in the guidance of oil exploration and development, have secured the exclusive services of geologists trained in oil geology. These strong corporations, most of which have lured away from the Survey a number of its best men, are able to organize geologic corps for themselves and to examine geologically great areas of unleased and untested lands in order more certainly to select the sections in which, other things being equal, the prospects for pools are most favorable and the hazards of dry holes the least. But these corporations rarely publish the original information gained by their geologists, and, whether or not the company is able to obtain all the lands it desires, the public is seldom much the wiser for these investigations at private expense.

The appeals to the Survey come mainly from citizens and land-owners singly and in groups, from chambers of commerce, and from delegations and communities. The Geological Survey is, by its

organic act, forbidden to make and therefore does not make examinations of private lands primarily in behalf of their owners, whether the owners are individuals or corporations. Its examinations are regional in extent, without regard to ownership, and when confined to small areas they are conducted without reference to property lines and with regard only to the geologic problems in hand and to the interests of the community and the Nation in the development of the mineral resources in the vicinity or district. In strict conformity with this principle, the results of all examinations and investigations are withheld until they are printed, either as press notices or as more formal reports, and in these forms they are simultaneously given out to all who ask for them.

Both through its own resources and through the cooperation of State surveys, the Federal Survey greatly extended its examination of oil structure during the year, and the results will be found in its current economic bulletins and in State reports. Yet in this field, as well as in others, the increase in extent and efficiency of the work made possible by the larger funds provided by Congress for this year has been insufficient to warrant attention to any except the most urgent calls on this national bureau for information regarding the geology of the country and for guidance in the discovery and development of its mineral resources. The increase both in the number and in the range of these calls is, in effect, proof of the public's growing appreciation of the value of the Survey work.

#### A CONTRIBUTION TO PUBLIC HEALTH.

The geologic resource of greatest value to the health of communities is a supply of pure drinking water. It is generally recognized that a number of diseases, prominent among which are typhoid fever and amœbic dysentery—a disease more common in tropical climates but found also in the United States—are contracted through contaminated water or contaminated food. Therefore a supply of pure water will eliminate one of the sources of such infection.

It is highly desirable to obtain supplies of domestic water from sources other than the shallow wells, some of them open, that are found near many houses. The water obtained from deep wells has percolated through sands and other material for so great a distance that its impurities have been removed by filtration, and it possesses a sanitary value that can not well be overestimated, for such water is free from the bacteria causing typhoid fever and the protozoa causing amœbic dysentery, and its use obviates the necessity for shallow wells that may serve as a breeding place for *Anopheles*, the mosquito to which malarial infection is due.

The United States Geological Survey for a number of years has been prosecuting, largely in cooperation with the State surveys, a

systematic study of the ground-water resources of all the Coastal Plain States. Reports have been issued, either by the Federal Survey or by cooperating State geological surveys, for Virginia, North Carolina, Georgia, Florida, Alabama, Mississippi, eastern Tennessee, Kentucky and southern Illinois, southeastern Missouri, southeastern Arkansas and Louisiana, northeastern Texas, the Black and Grand Prairie areas of Texas, and the area underlain by Tertiary formations in Texas south of the latitude of Jefferson and east of Brazos River. The manuscripts of papers on the ground-water resources of Delaware and Maryland, on the ground waters of northeastern Arkansas, and on the ground waters of Lasalle and McMullen counties, Tex., have been completed and will be published during the next fiscal year. Additional studies of the ground waters of Mississippi are in progress and it is hoped that within the next year the manuscript will be transmitted for publication. Comprehensive studies of the ground-water resources of the Coastal Plain of Texas west of Brazos River are approaching completion, and the manuscript of a report will be submitted for publication within a year.

With good health recognized as one of the great national assets, the extent of this study of underground-water resources furnishes a measure of its value to the public. Reports have been published covering 376,000 square miles in the Atlantic and Gulf States, reports on 27,000 square miles are completed though not yet published, field work has been completed on 50,000 square miles, and work is contemplated to cover 16,000 square miles. These areas of nearly half a million square miles include the parts of the United States in which impure water supplies involve the greatest danger. The value of such surveys in conserving public health has already been demonstrated, for it has been noted that wherever an adequate supply of deep-well water has been obtained, typhoid fever, amœbic dysentery, and malaria have abated.

The methods used by geologists in working out the distribution of ground waters are complex, but it is noteworthy that among the more significant criteria used are the fossil remains occurring in the different beds. Each one of the geologic horizons usually has its distinctive fossils, and by an accurate knowledge of these vestiges of organisms the geologist is aided in recognizing particular geologic formations. In this way he may be able to determine by means of the samples taken from the bore the depth to a certain water horizon.

That paleontology, so generally regarded as a purely scientific study, has a great value in the investigation of economic resources may not be generally recognized. In order, however, to understand the conditions controlling the occurrence of any one of three of the most important mineral resources—ground waters, coal, and oil and gas—an accurate knowledge of the succession of the different

rock sheets and their geologic structure is essential, and the determination of that order of succession depends upon the study of fossil remains included in these rocks. The value of the work of the paleontologists who have studied the geologic formations in the Coastal Plain area is therefore inestimable. Among the men who have aided in the paleontologic characterization of horizons and thereby assisted in the development of the ground water and oil and gas resources of the Coastal Plain, W. H. Dall, G. D. Harris, and R. T. Hill should be specially mentioned. The excellent work of these scientists has been continued either by themselves or by others who have entered the same fields, and it is hoped that within a few years there may be available biologic characterizations of all the Tertiary and Cretaceous formations of the Coastal Plain. Additional accurate information will assist in the further development of many of the natural resources of the Coastal Plain region.

It is unfortunate that the paleontologists are subjected to increasing overwork, and it is to be regretted that on account of inadequate funds the distinguished Survey specialists engaged in these important studies, which are particularly in demand by the cooperating State surveys, can not be provided with assistance.

It should be added that the science of paleontology has a large educational value, and its popular interest is well illustrated in the western guidebooks, just published. As with geology in general, so in paleontology, the Survey is the central public source of information.

#### CHANGES IN PERSONNEL.

The death of Henry Gannett, on November 5, 1914, terminated a long and important service. Mr. Gannett was connected with the Survey, with a few interruptions, since 1882 and accomplished much in establishing the methods and fixing the standards of the topographic work in the early days of the organization. He held the title of chief geographer (or chief topographer) in the years 1882 to 1896. His Government work outside of the Survey, chiefly work on the census of the United States, Cuba, Porto Rico, and the Philippines, and his services as chairman of the United States Geographic Board and as geographer of the National Conservation Commission, covered a wide field of geographic investigations and showed large grasp of new problems. He was also president of the National Geographic Society.

Among the important resignations or transfers from the Survey within the fiscal year were those of David T. Day and E. W. Parker. These two men are to be credited with the development of the division of mineral resources, a service that is unique among the statistical organizations of the world. Dr. Day, after a service of nearly 30 years, was transferred August 31, 1914, to the Bureau of Mines,



where, as consulting chemist, he will continue his investigation of the special problems connected with the technology of petroleum, devoting part of his time to this Government work. Mr. Parker, who served in various positions in the Survey since 1891 and who has been in charge of the collection of statistics of the mineral resources of the United States since 1908, resigned June 30, 1915, to accept an important position with the anthracite-coal interests. Mr. Parker's resignation necessitated several changes in the division of mineral resources—the appointment of Hiram D. McCaskey as geologist in charge, of E. F. Burchard as geologist in charge of the section of nonmetallic resources, and of C. E. Leshner, associate geologist, to take charge of the statistics of coal. The number of men designated to take up the work relinquished by Mr. Parker is perhaps the strongest indication of the amount and importance of that work, which he so long successfully carried on.

Mr. E. C. Barnard, geographer, resigned May 2, 1915, after a service of more than 30 years, to accept the position of expert commissioner on the part of the United States in the International Boundary Commissions (Canada). Since 1910 Mr. Barnard's connection with the Geological Survey has been only nominal, by reason of his detail to the State Department in connection with the surveys of the international boundary.

Other changes in the organization were the appointment, in January, of Philip S. Smith as administrative geologist and, in the absence of the Director, Acting Director, and the appointment, in February, of Guy E. Mitchell as chief of the executive division. Mr. Mitchell was succeeded by T. P. O'Hara as private secretary to the Director.

#### **EXHIBIT AT PANAMA-PACIFIC EXPOSITION.**

With a small allotment from the congressional appropriation for the Government exhibit at the Panama-Pacific Exposition, San Francisco, the Survey has made a creditable and instructive exhibit, including scenarios showing many of the kinds of work done by the Survey in exploring and investigating the resources of the country; an exhibit of the per capita production of minerals of the United States; an exhibit of the use of many of the minerals in the rough and in the manufactured form; and specimens, maps, pictures, and instruments illustrative of various subjects studied or used by the Survey. Ralph W. Stone, geologist, was detailed to have charge of the exhibit and to give illustrated lectures daily describing the work of the Survey. The Survey has been awarded one grand prize, three medals of honor, three gold medals, two silver medals, and one bronze medal. Silver medals for collaboration were also awarded to the following Survey members: George H. Ashley, A. H. Brooks, J. C. Hoyt, S. J. Kübel, R. B. Marshall, and Edward W. Parker.

### SCOPE OF THE WORK.

In the following pages of this administrative report the activities of each branch of the Survey are set forth in detail; the following paragraph is a brief summary of the whole. Geologic investigations were made in 47 States and Alaska; topographic surveys were made in 30 States, Alaska and Hawaii, and stream measurements were made in 41 States and Hawaii. The total area covered by the geologists in reconnaissance and detailed surveys was more than 76,000 square miles and the area topographically mapped by the topographers was more than 35,000 square miles. The land-classification work of the Geological Survey last year resulted in the classification of about 36,000 square miles in the public-land States. In the collection of statistics of mineral production the Geological Survey cooperated with the State geologists of 16 States and carried on correspondence with 90,000 producers.

### WORK OF THE YEAR.

#### PUBLICATIONS.

The work of the Geological Survey is reflected chiefly in the publication and distribution of its printed reports and maps. The publications of the year consisted of 1 annual report, 1 monograph, 5 professional papers, 10 separate chapters from 2 professional papers, 35 bulletins, 30 separate chapters from 5 bulletins, 33 water-supply papers, 18 separate chapters from 4 water-supply papers, 1 annual report on mineral resources for 1913 (published also in 62 advance chapters, 15 delivered in 1913-14 and 47 in 1914-15), 5 advance chapters from the annual report on mineral resources for 1914, 3 geologic folios, 2 lists of publications, 1 list of topographic maps and folios, pamphlets entitled "Topographic instructions of the United States Geological Survey, 1915," and "Service bulletin, 1914," leaflets entitled "Nature and uses of topographic maps," "The production of copper in 1914," and "The production of spelter in 1914," 3 circulars concerning geologic folios, 22 index-map circulars, 55 press bulletins, and 10 monthly lists of new publications. The total number of pages in these publications was 23,574, a notable increase from the preceding year and a larger number than in any other year of the Survey's history. The publications of the year 1913-14 comprised 16,631 pages.

Brief notes on the publications of the year are given below.

THIRTY-FIFTH ANNUAL REPORT OF THE DIRECTOR of the United States Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1914. 1914. 163 pages, 2 plates.

A detailed account of the work of the Geological Survey during the fiscal year 1914, with a statement of the total appropriation made by Congress for the Survey



and the allotments for each kind of work. Under the heading "Special features" is a brief discussion of the province of a Federal Survey. The report also includes abstracts of the publications of the year and maps of the United States showing areas covered by topographic and geologic surveys.

**MONOGRAPH 53.** The Pleistocene of Indiana and Michigan and the history of the Great Lakes, by Frank Leverett and F. B. Taylor. 1915. 529 pages, 32 plates, 15 text figures. Price \$1.50.

Describes in detail the glacial features and the great glacial lakes of a district which includes a considerable part of Indiana and all of the southern peninsula of Michigan. The question of a pre-Illinoian drift in southern Indiana is briefly treated, but the Wisconsin drift, the concealed portions of the earlier drift sheets that underlie it, and the somewhat intricate lake history associated with and following the retreat of the ice are the main subjects of discussion. The monograph is profusely illustrated with maps showing the topography and geology of the area discussed, glacial lakes and eskers, ancient lake beaches, morainic systems, profiles of warped water planes, and river distributaries. It is closely related to Monographs 38 and 41, which treat of glacial geology in districts directly adjoining that discussed in the present report.

**PROFESSIONAL PAPER 85.** Shorter contributions to general geology, 1913. David White, chief geologist. 1914. 99 pages, 14 plates, 7 text figures.

The first volume of a new series to be published annually by the Geological Survey under the title "Shorter contributions to general geology." In advance of the printing of the full volume, separates, each including one or more papers, are issued to the number of 10 or 12 a year as the manuscript and illustrations are ready without waiting until the material for the full volume is in hand or even promised. These separates are paged continuously, so that the volume is simply a consolidation of the separates, without change of pagination. The papers included in these "Shorter contributions to general geology" may relate to any phase of geology, provided it possesses general interest—petrology, paleontology, stratigraphy, glaciology, structural geology, etc. This volume is intended not as a catch-all for current odds and ends, but as a dignified collection of scientific contributions, each suitable in importance of subject, value of results, and quality of treatment for separate publication as a bulletin or professional paper if it were of sufficient length.

Professional Paper 85 contains the following contributions:

The origin of colemanite deposits, by H. S. Gale.

The mud lumps at the mouths of the Mississippi, by E. W. Shaw.

Interpretation of anomalies of gravity, by G. K. Gilbert.

The Jurassic flora of Cape Lisburne, Alaska, by F. H. Knowlton.

Resins in Paleozoic plants and in coals of high rank, by David White.

**PROFESSIONAL PAPER 86.** The transportation of débris by running water, by G. K. Gilbert, based on experiments made with the assistance of E. C. Murphy. 1914. 263 pages, 3 plates, 89 text figures.

The finer débris transported by a stream is borne in suspension; the coarser is swept along the channel bed. The suspended load is readily sampled and estimated, and much is known as to its quantity. The bed load is inaccessible, and we are without definite information as to its amount. The primary purpose of the investigation of which Professional Paper 86 is the outcome was to learn the laws which control the movement of the bed load, and especially to determine how the quantity of load is related to the stream's slope and discharge, and to the degree of comminution of the débris. The paper contains the record and discussion of a series of experiments made in a specially equipped laboratory at the University of California, Berkeley, in the years 1907-1909.

**PROFESSIONAL PAPER 87.** Geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska, by C. W. Wright. 1915. 110 pages, 22 plates, 11 text figures.

A detailed description of the geology of Kasaan Peninsula and Copper Mountain, the two most important copper-bearing areas in southeastern Alaska, prefaced by a general account of the geology of the Ketchikan district, within which these areas lie. The mining development is only briefly discussed, because it is not of permanent interest and is fully treated in the Survey's annual bulletins showing the progress of investigations of mineral resources in Alaska. The genesis and occurrence of the copper ores are discussed, and special attention is paid to contact deposits, which are well exemplified in this region. The illustrations include a geologic map of the Ketchikan district, topographic and geologic maps of Copper Mountain and Kasaan Peninsula, plans and sections of mines, and halftone views of rocks and minerals from the areas discussed.

**PROFESSIONAL PAPER 88.** Lavas of Hawaii and their relations, by Whitman Cross. 1915. 97 pages, 4 plates.

Describes in detail the petrography of the Hawaiian Archipelago, treating each of the larger islands individually. It is an accepted generalization concerning the Hawaiian Islands that they have been built up by a long-continued series of volcanic eruptions beginning at a point far west of the principal islands of to-day. They represent, therefore, the higher summits of a chain of volcanic mountains, mainly submarine, rising from an ocean floor more than 20,000 feet below the surface of the sea and extending for about 1,800 miles in a general north-northwesterly direction. They appear to form a simple petrographic province whose igneous rocks are clearly consanguineous. The paper also discusses the mineral, chemical, and normative composition of the Hawaiian lavas, as well as their distribution and association, and the theoretical bearings of the data presented. A map of the islands, photomicrographs of the rocks, a diagram illustrating variation in normative composition of the lavas, and a table of normative ratios and symbols, accompany the report.

**PROFESSIONAL PAPER 90.** Shorter contributions to general geology, 1914. David White, chief geologist. 1915. 199 pages, 21 plates, 20 text figures.

A consolidation of 12 short papers which were first issued as parts A to L, inclusive, forming the second annual volume bearing this title. The corresponding volume for 1913 was Professional Paper 85.

Professional Paper 90 contains the following contributions:

Geology of the pitchblende ores of Colorado, by E. S. Bastin.

Erosion and sedimentation in Chesapeake Bay around the mouth of Choptank River, by J. F. Hunter.

Dike rocks of the Apishapa quadrangle, Colorado, by Whitman Cross.

The composition of crinoid skeletons, by F. W. Clarke and W. C. Wheeler.

Contributions to the stratigraphy of southwestern Colorado, by Whitman Cross and E. S. Larsen.

A reconnaissance in the Canyon Range, west-central Utah, by G. F. Loughlin.

The Montana group of northwestern Montana, by Eugene Stebinger.

A deep well at Charleston, S. C., by L. W. Stephenson, with a report on the mineralogy of the water by Chase Palmer.

The stratigraphy of the Montana group, with special reference to the position and age of the Judith River formation in north-central Montana, by C. F. Bowen.

The Cretaceous-Eocene contact in the Atlantic and Gulf Coastal Plain, by L. W. Stephenson.

The history of a portion of Yampa River, Colorado, and its possible bearing on that of Green River, by E. T. Hancock.

The inorganic constituents of echinoderms, by F. W. Clarke and W. C. Wheeler.

**PROFESSIONAL PAPER 95-A.** Composition of muds from Columbus Marsh, Nevada, by W. B. Hicks. 1915. pp. 1-11, fig. 1.

A part of Professional Paper 95, "Shorter contributions to general geology, 1915." Professional Paper 95-A is a further report on the investigation of the dry lake of Columbus Marsh, situated on or near the line between Esmeralda and Mineral counties, Nev. The investigation of this lake, begun in 1912, had for its economic motive the discovery of potash. Results of the work done in 1912 are given in Bulletin 540-N. Professional Paper 95-A tells of the work done in 1913, which included the drilling of one shallow well and the collection of a set of surface samples of muds from the marsh. After considering all the facts at hand, the author expresses his belief that large amounts of potash have been absorbed from surrounding or percolating solutions and are held in loosely combined form by the muds of Columbus Marsh and perhaps by the muds of the desert basins in general, while the other salts, being less completely absorbed, have been gradually concentrated through evaporation. This theory explains the presence of the natural brines and salt incrustations with low potash content now found in the desert regions of the United States.

**PROFESSIONAL PAPER 95-B.** Eocene glacial deposits in southwestern Colorado, by W. W. Atwood. 1915. pp. 13-26, Pls. I-IV, figs. 2-11.

Professional Paper 95-B describes briefly the geology of the Montrose quadrangle, near Ridgway, Colo., at the base of the San Juan Mountains. This locality is of especial interest because one series of its exposed rocks includes a section of glacial till that is overlain by formations of Tertiary age. These exposures were found in September, 1913, in the same region where three distinct stages of Pleistocene glaciation among the mountains were demonstrated in 1912. The illustrations include a map of the area discussed, showing distribution of Eocene and Pleistocene glacial deposits, and geologic sections at several localities near Ridgway, Colo.

**BULLETIN 541.** Contributions to economic geology (short papers and preliminary reports), 1912, Part II, Mineral fuels—M. R. Campbell, geologist in charge. 1914. 532 pages, 29 plates, 17 text figures.

This bulletin includes 26 brief reports of two classes—(1) short papers giving comparatively detailed descriptions of occurrences that have economic interest but are not of sufficient importance to warrant a more extended description; (2) preliminary reports on economic investigations, the results of which are to be published later in more detailed form. These papers are such only as have a direct economic bearing, all topics of purely scientific interest being excluded. They have been grouped according to subjects or general regions, and each group has been issued as an advance chapter as soon as it was ready. A complete list of the papers included in the volume follows:

Oil and gas in the northern part of the Cadiz quadrangle, Ohio, by D. D. Condit.

Gas from mud lumps at the mouths of the Mississippi, by E. W. Shaw.

Structure of the Fort Smith-Poteau gas field, Arkansas-Oklahoma, by C. D. Smith.

The Glenn oil and gas pool and vicinity, Oklahoma, by C. D. Smith.

The Douglas oil and gas field, Converse County, Wyo., by V. H. Barnett.

The Shoshone River section, Wyoming, by D. F. Hewett.

Oil and gas near Green River, Grand County, Utah, by C. T. Lupton.

Petroleum near Dayton, N. Mex., by G. B. Richardson.

Reconnaissance of the Barstow-Kramer region, California, by R. W. Pack.

Rhode Island anthracite, by G. H. Ashley.

Coking coal in Powell Mountain, Scott County, Va., by M. R. Campbell.

The coal resources and general geology of the Pound quadrangle of Virginia and Kentucky, by Charles Butts.

The coal resources of a part of northeastern Missouri, by F. C. Greene.

The Cannonball River lignite field, Morton, Adams, and Hettinger counties, N. Dak., by E. R. Lloyd.

Lignite in the vicinity of Plentywood and Scobey, Sheridan County, Mont., by C. M. Bauer.

Geology and coal resources of the area southwest of Custer, Yellowstone, and Bighorn counties, Mont., by G. S. Rogers.

Coal discovered in a reconnaissance survey between Musselshell and Judith, Mont., by C. F. Bowen.

The Cleveland coal field, Blaine County, Mont., by C. F. Bowen.

The Big Sandy coal field, Chouteau County, Mont., by C. F. Bowen.

The Horseshoe Creek district of the Teton Basin coal field, Fremont County, Idaho, by E. G. Woodruff.

The Glacier coal field, Whatcom County, Wash., by E. G. Woodruff.

The Eden Ridge coal field, Coos County, Oreg., by C. E. Leshner.

Geology and coal resources of the Sierra Blanca coal field, Lincoln and Otero counties, N. Mex., by C. H. Wegemann.

Coal near Thompson, Grand County, Utah, by F. R. Clark.

Coal near Wales, Sanpete County, Utah, by F. R. Clark.

Analyses of coal samples from various fields in the United States, by M. R. Campbell.

**BULLETIN 544.** Fauna of the Wewoka formation of Oklahoma, by G. H. Girty. 1915. 353 pages, 35 plates.

Describes the fauna of the Wewoka formation, which is typically exposed in the Coalgate and Wewoka quadrangles, in Atoka, Coal, Hughes, Okfuskee, Okmulgee, Pittsburg, Pontotoc, and Seminole counties, Okla. This formation occupies a part of the Carboniferous area of Oklahoma, which is especially interesting because its rocks were laid down under physical conditions so much at variance with those of the Carboniferous areas farther north and east that both its sediments and its faunas show marked differences from those of the other areas. The fossils of the Wewoka formation are in an excellent state of preservation and offer an opportunity for careful generic and specific studies which may serve as a starting point for work in less satisfactory material. The illustrations show specimens of the fossils described in the report.

**BULLETIN 548.** Electric activity in ore deposits, by R. C. Wells. 1914. 78 pages, 7 text figures.

A contribution to the study of ore deposits, showing that contact with solutions, as well as some other conditions, may impart electric energy to certain metaliferous minerals, thus transforming them into conductors of electric currents in ore deposits. Under certain conditions the valuable metals may be deposited from solutions by electrolytic action and thereafter be protected from redissolving by contact with any of the more oxidizable ores. Although the results thus far obtained afford no adequate basis for any method of electric prospecting, this bulletin possesses value in the broader investigation of ores, for even feeble currents may exert a directional influence on ore deposition, and chemical conditions, even at a distance, may be a factor in determining mineral association. The illustrations consist of diagrams showing apparatus and methods used in studying currents produced by combinations of solutions and minerals.

**BULLETIN 549.** The Shinumo quadrangle, Grand Canyon district, Arizona, by L. F. Noble. 1914. 100 pages, 18 plates, 1 text figure.

Ever since Powell's daring boat trip down the Colorado in 1869 geologists have known that the walls of the Grand Canyon display one of the most remarkable and instructive geologic sections in the world. Bulletin 549 treats of the geology of part of this district—the Shinumo quadrangle, covering about 270

square miles in Coconino County, northern Arizona. Although the book contains considerable lithologic and stratigraphic material that will scarcely interest those who are not geologists, the author has very properly remembered that the people as a whole have unusual claims to consideration in any publication dealing with the Grand Canyon, and has skillfully supplied as a setting to his more strictly scientific work much vivid description and lucid explanation, which will help all those who take more than a transient and superficial interest in what they see to understand one of the most impressive and significant of the inanimate works of nature.

The map which accompanies this bulletin represents the first geologic mapping done in the canyon that attains the standard of accuracy and detail set for the Geologic Atlas of the United States.

**BULLETIN 550.** The ore deposits of northeastern Washington, by Howland Bancroft including a section on the Republic mining district by Waldemar Lindgren and Howland Bancroft. 1914. 215 pages, 19 plates, 26 text figures.

Describes the geology of an area of about 6,000 square miles in Stevens and Ferry counties, northeastern Washington, giving detailed information as to its mining districts and ore deposits—chiefly lead, zinc, and copper. States that the general conditions for mining are particularly favorable and discusses briefly the methods and costs of mining, treatment of the ores, and means of transportation. The illustrations include plans and sketch maps of some of the mines and halftone plates showing geologic conditions.

**BULLETIN 559.** Results of spirit leveling in Michigan, 1911 and 1913—R. B. Marshall, chief geographer. 1914. 79 pages, 1 plate.

**BULLETIN 560.** Results of spirit leveling in Minnesota, 1897 to 1914, inclusive, R. B. Marshall, chief geographer. 1915. 190 pages, 1 plate.

**BULLETIN 561.** Results of spirit leveling in Hawaii, 1910 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 42 pages, 1 plate.

**BULLETIN 562.** Results of spirit leveling in Virginia, 1900 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 68 pages, 1 plate.

**BULLETIN 563.** Results of spirit leveling in Maryland, 1896 to 1911, inclusive. R. B. Marshall, chief geographer. 1914. 80 pages, 1 plate.

**BULLETIN 566.** Results of spirit leveling in Utah, 1897 to 1914, inclusive. R. B. Marshall, chief geographer. 1915. 77 pages, 1 plate.

**BULLETIN 567.** Results of spirit leveling in Idaho, 1896 to 1914, inclusive. R. B. Marshall, chief geographer. 1915. 130 pages, 1 plate.

**BULLETIN 569.** Results of spirit leveling in Iowa, 1896 to 1913, inclusive. R. B. Marshall, chief geographer. 1915. 126 pages, 1 plate.

**BULLETIN 570.** Results of spirit leveling in Wisconsin, 1897 to 1914, inclusive. R. B. Marshall, chief geographer. 1914. 86 pages, 1 plate.

**BULLETIN 572.** Results of spirit leveling in Nebraska, 1896 to 1913, inclusive. R. B. Marshall, chief geographer. 1914. 57 pages, 1 plate.

Reports on precise and primary leveling in the States mentioned, showing the exact altitude of a great number of places. The work in Michigan, Hawaii, and Maryland, and part of that in Minnesota, Virginia, Iowa, and Nebraska was done in cooperation with the States. Each bulletin contains a halftone plate showing Geological Survey designs for bench marks.

**BULLETIN 574.** Mining districts of the Dillon quadrangle, Montana, and adjacent areas, by A. N. Winchell. 1914. 191 pages, 8 plates, 16 text figures.

A sketch of the geology of the Dillon quadrangle, which covers about 3,200 square miles in southwestern Montana, and detailed descriptions of its mining districts. The illustrations consist of geologic sketch maps of many of the districts and halftone plates showing geologic conditions.



**BULLETIN 576.** Geology of the Hanagita-Bremner region, Alaska, by F. H. Moffit. 1914. 56 pages, 6 plates, 6 text figures.

This bulletin presents information about a region that was very little known prior to 1911. Although the author's survey was of a reconnaissance character it was sufficiently detailed to outline the geography, general geology, and geologic history of the region and to obtain information about the occurrence and distribution of the gold and copper deposits. The Hanagita-Bremner region includes some mineral deposits which, though almost undeveloped, give promise of becoming commercially valuable, now that they have been made comparatively accessible by the railroad recently completed up the Copper River valley. The illustrations include topographic and geologic reconnaissance maps, a map showing the distribution of timber, and diagrams illustrating some of the methods of formation of canyons and other stream channels.

**BULLETIN 577.** Geology of the phosphate deposits northeast of Georgetown, Idaho, by R. W. Richards and G. R. Mansfield. 1914. 76 pages, 14 plates, 3 text figures.

This report discusses briefly the geography and geology of an area in Bear Lake and Bannock counties, southeastern Idaho, and a part of Georgetown Canyon. Detailed descriptions, by townships, of the phosphate deposits are given, and the book contains geologic maps and sections of many of the phosphate-bearing districts. The type of geologic survey represented in this work is a development of the constantly increasing requirement for detail. The delineation of phosphate outcrops in areas beyond the properties that have been located and the estimation of the depth, tonnage, and quality of the different beds furnish part of the data.

**BULLETIN 578.** The Iditarod-Ruby region, Alaska, by H. M. Eakin. 1914. 45 pages, 6 plates, 1 text figure.

Describes an area in west-central Alaska between the mining settlements on Iditarod River and those on the Yukon at Ruby, visited by the author in the summer of 1913. This volume is the third report based on work inspired by the discovery of gold in the Innoko district in 1906. The author shows that the bedrock sources of the placer gold in this district include the igneous intrusive rocks and the Cretaceous sediments at or near their contacts with the intrusives; also that the auriferous lodes thus far found are closely associated with dikes and other intrusive rocks. These conditions augur well for the future of the mining industry of the region, for similar conditions exist in other parts of Alaska where gold mining is successfully carried on.

**BULLETIN 579.** Reconnaissance of oil and gas fields in Wayne and McCreary counties, Ky., by M. J. Munn. 1914. 105 pages, 6 plates, 6 text figures.

Gives a brief description of the stratigraphy and structure of the rocks in Wayne and McCreary counties, Ky., with especial reference to their oil and gas content. The oil and gas fields are treated in detail, and numerous records of wells are given. As to the future of the area, there is every reason to suppose that many other profitable oil pools will be found eventually in districts in and adjacent to Wayne County, and the structural conditions seem to favor the practical application of geology in finding these pools. The illustrations include sketch maps showing the location of oil and gas pools, sections of deep wells, and views of specimens from the Beaver Creek oil "sand."

**BULLETIN 580.** Contributions to economic geology (short papers and preliminary reports), 1913, Part I, Metals and nonmetals except fuels. F. L. Ransome and H. S. Gale, geologists in charge. 1915. 462 pages, 9 plates, 97 text figures.

This bulletin is made up of 16 brief reports on investigations of mineral deposits except fuels in the United States in 1913. The papers included are of the two classes indicated for Bulletin 541 (p. 19). A list of the papers, arranged according to subjects, is given below:

*Gold and silver.*

Gold placers on Wind and Bighorn rivers, Wyoming, by F. C. Schrader.  
 Lode deposits of the Alleghany district, California, by H. G. Ferguson.  
 The Rochester mining district, Nevada, by F. C. Schrader.

*Copper.*

Notes on the Unaweep copper district, Colorado, by B. S. Butler.  
 The Grand Gulch mining region, Mohave County, Ariz., by J. M. Hill.

*Lead and zinc.*

The Darwin silver-lead mining district, California, by Adolph Knopf.  
 Some cerusite deposits in Custer County, Colo., by J. F. Hunter.  
 Ore deposits in the Sawtooth quadrangle, Blaine and Custer counties, Idaho,  
 by J. B. Umpleby.

*Rare metals.*

Carnotite near Mauch Chunk, Pa., by E. T. Wherry.  
 The rutile deposits of the eastern United States, by T. L. Watson.

*Phosphates.*

The phosphate deposits of South Carolina, by G. S. Rogers.  
 The Elliston phosphate field, Montana, by R. W. Stone and C. A. Bonine.

*Salines.*

Salines in the Owens, Searles, and Panamint basins, southeastern California,  
 by H. S. Gale.

*Miscellaneous.*

A new gypsum deposit in Iowa, by G. F. Kay.  
 Some deposits of mica in the United States, by D. B. Sterrett.  
 Publications by Survey authors on metals and nonmetals except fuels, com-  
 piled by I. P. Evans.

BULLETIN 581. Contributions to economic geology (short papers and preliminary reports), 1913, Part II, Mineral fuels. M. R. Campbell and David White, geologists in charge. 1915. 187 pages, 11 plates, 6 text figures.

This bulletin includes six brief reports of the two classes indicated for Bulletin 541 (p. 19). A list of the papers follows:

*Petroleum and natural gas.*

Oil shale of northwestern Colorado and northeastern Utah, by E. G. Woodruff and D. T. Day.

Oil and gas in the western part of the Olympic Peninsula, Wash., by C. T. Lupton.

The Moorcroft oil field, Crook County, Wyo., by V. H. Barnett.

Possibilities of oil in the Big Muddy dome, Converse and Natrona counties, Wyo., by V. H. Barnett.

Geology and oil prospects in Waltham, Priest, Bitterwater, and Peachtree valleys, Cal., by R. W. Pack and W. A. English.

*Coal.*

The Coalville coal field, Utah, by C. H. Wegemann.

BULLETIN 582. Mineral deposits of the Santa Rita and Patagonia mountains, Arizona, by F. C. Schrader, with contributions by J. M. Hill. 1915. 373 pages, 25 plates, 46 text figures.



The purpose of this paper is to furnish a general idea of the character, occurrence, distribution, and development of the mineral resources of a desert area comprising about 1,400 square miles in Pima and Santa Cruz counties, Ariz., 26 miles southeast of Tucson. The physiography, geology, and water supply of the area are briefly discussed, and the mining districts, camps, and properties are considered in detail. The deposits include gold, silver, copper, lead, zinc, tungsten, molybdenum, and building materials. Topographic and geologic maps of the area discussed and of parts of it, maps, plans, and sections of some of the mines and their workings, and halftone plates showing geologic features make up the illustrations.

**BULLETIN 583.** Colorado ferberite and the wolframite series, by F. L. Hess and W. T. Schaller. 1914. 75 pages, 14 plates, 35 text figures.

This report is made up of two papers, namely, "The mineral relations of ferberite," by Mr. Hess, and "Crystallography of ferberite from Boulder County, Colo.," by Mr. Schaller. Ferberite, as ordinarily defined, is that mineral of the wolframite series which is composed wholly or almost wholly of iron tungstate and which, like other wolframites, crystallizes in the monoclinic system. It is comparatively rare and where found seems to occur in small quantities only. It occurs in largest quantity in the locality described in this report. The illustrations of Bulletin 583 include diagrams and halftone plates representing crystals of ferberite.

**BULLETIN 584.** Bibliography of North American geology for 1913, with subject index, by J. M. Nickles. 1914. 183 pages.

A list, arranged alphabetically by authors' names, of publications on the geology of the continent of North America and adjacent islands, also Panama and the Hawaiian Islands, issued in 1913. The work is indexed and contains lists of chemical analyses reported and minerals, rocks, and formations described.

**BULLETIN 586.** Slate in the United States, by T. N. Dale and others. 1914. 220 pages, 26 plates, 18 text figures.

This volume is not only a corrected and revised edition of Bulletin 275, "Slate deposits and slate industry of the United States," but also contains the results of all recent discoveries and studies of slate in this country. Its plan is (1) to set forth, in succinct form, the present state of scientific knowledge as to the origin, structure, texture, and chemical and mineral composition of slate; (2) to describe in more or less detail the slates and quarries of each district; and (3) to consider the economic geology of slate, including scientific prospecting for it, methods of testing it, slate machinery, and the uses of slate and slate waste, together with a tabular summary of the slates described. The book is illustrated by numerous maps showing the location of slate deposits and quarry sites in New England, the Middle Atlantic States, and Arkansas, and halftone plates showing some of the quarries.

**BULLETIN 588.** The constitution of the natural silicates, by F. W. Clarke. 1914. 128 pages.

This bulletin represents the results of a study of the chemical structure of the silicates found in the solid crust of the earth. From the geologist's point of view the silicates are of fundamental importance, for they form at least nine-tenths of the entire known mass of the earth's crust, and a study of their inner constitution may be reasonably expected to shed light upon many serious problems. Every primitive rock or eruptive mass contains an aggregation of silicates, each one capable of undergoing chemical change by which alteration products are formed, so that in time the rock may become transformed into new substances, quite unlike those which originally existed in it. A knowledge of the processes which thus occur, dependent on chemical structure, should be

applicable to the study of the rocks and should ultimately render it possible so to investigate a metamorphosed mass as to clearly indicate its origin.

**BULLETIN 589.** The calcite marble and dolomite of eastern Vermont, by T. N. Dale. 1914. 67 pages, 2 plates, 11 text figures.

A companion report to Bulletin 521, "The commercial marbles of western Vermont," by the same author. The region discussed in the earlier report includes the most extensive marble industry in the United States, whereas Bulletin 589 relates to a virgin field whose development is still a work of the future. The object of this bulletin is twofold—to locate definitely and describe accurately the marbles and dolomites of eastern Vermont with a view to setting forth their possible economic uses and to discuss whatever features of scientific interest they may present. To this end the deposits are treated in detail by counties and towns. The illustrations include a map of the State and maps of many of the townships, showing the marble and dolomite localities described.

**BULLETIN 590.** Reconnaissance of the geology and oil prospects of northwestern Oregon, by C. W. Washburne. 1914. 111 pages, 1 plate.

This report is based on a hasty reconnaissance, made during the summer of 1910, of a certain part of the Coast Range of Oregon, where the presence of oil had been suggested by the topographic similarity of the locality to the oil regions of California. It contains a brief description of the geology of the district as a whole and of each county, as well as discussions of the oil and gas indications in each county. The author concludes that there is no good reason for believing that oil will be found in the northern part of the Coast Range of Oregon. A map of northwestern Oregon showing gas and oil prospects accompanies the report.

**BULLETIN 592.** Mineral resources of Alaska—report on progress of investigations in 1913, by A. H. Brooks and others. 1914. 413+xi pages, 17 plates, 13 text figures.

A collection of 21 papers by 13 authors on the work of the Geological Survey in Alaska during 1913. Papers of a general character are presented first, followed by those treating of special districts, arranged geographically from south to north. The book contains preliminary statements on investigations made during the year and summaries of the conditions of the mining industry, including statistics of mineral production. It is illustrated by maps showing the distribution of mineral resources in the whole Territory and in certain portions of it and by sketch maps showing the location of lode prospects in some of the districts. The titles of the papers are given below:

Administrative report, by A. H. Brooks.

The mineral deposits of Alaska, by A. H. Brooks.

The Alaskan mining industry in 1913, by A. H. Brooks.

Lode mining in the Ketchikan region, by P. S. Smith.

Marble resources of the Juneau, Skagway, and Sitka districts, by E. F. Burchard.

A barite deposit near Wrangell, by E. F. Burchard.

Mineral deposits of the Yakataga district, by A. G. Maddren.

Preliminary report on a water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport.

The Port Wells gold-lode district, by B. L. Johnson.

Mining on Prince William Sound, by B. L. Johnson.

Gold lodes and placers of the Willow Creek district, by S. R. Capps.

Mineral resources of the upper Matanuska and Nelchina valleys, by G. C. Martin and J. B. Mertie, jr.

Preliminary report on the Broad Pass region, by F. H. Moffit.

Mining in the Valdez placer district, by F. H. Moffit.

The Chisana placer district, by A. H. Brooks.

Lode mining near Fairbanks, by Theodore Chapin.

Placer mining in the Yukon-Tanana region, by Theodore Chapin.

Placer mining in the Ruby district, by H. M. Eakin.

Mineral resources of the Yukon-Koyukuk region, by H. M. Eakin.

Placer mining on Seward Peninsula, by Theodore Chapin.

Lode developments on Seward Peninsula, by Theodore Chapin.

**BULLETIN 594.** Some mining districts in northeastern California and northwestern Nevada, by J. M. Hill. 1915. 200 pages, 19 plates, 4 text figures.

A general outline of the geology of a part of northern California and northwestern Nevada, with a brief statement of the nature and occurrence of the ore deposits as a whole and detailed descriptions of individual mining districts. In these descriptions the following points concerning the districts are considered: Location, accessibility, history, production, climate and vegetation, topography, geology, type and origin of the ore deposits, and origin and character of the veins. Sketch maps of the districts, structure sections of the mountain ranges, and half-tone plates showing geologic features make up the illustrations.

**BULLETIN 596.** Geology and coal resources of North Park, Colo., by A. L. Beekly. 1915. 121 pages, 12 plates, 1 text figure.

Describes the geography, stratigraphy, structure, and economic geology of North Park, a great natural depression in the Rocky Mountains of northern Colorado, sharply defined as a topographic unit by its prominent, almost continuous rim of mountain crests 2,000 to 5,000 feet above the bottom of the basin. On account of its remoteness from frequented routes of travel, very little has been known of the geology of this basin until recent years. As coal is the most valuable known mineral resource of North Park, this report calls special attention to the coal deposits, discussing their occurrence and development and the production and estimated tonnage of the mines. The illustrations consist of a geologic map and sections of North Park, sections of coal beds, and photographic views of geologic features.

**BULLETIN 599.** Our mineral reserves—how to make America industrially independent, by G. O. Smith. 1914. 48 pages.

The readjustments in the world's commerce necessitated by the European war have already imposed new conditions on the mineral industry as well as on other industries. Second only in importance to the food supply is the supply of mineral products necessary to meet the requirements of twentieth-century civilization. The United States has cause for congratulation in the facts that it is almost independent in the possession of essential mineral resources and that the interference with manufacturing caused by interruption of the importation of many necessary raw materials may be overcome almost wholly by development of neglected resources in our own country. Beginning in August, 1914, there was a lively demand for information regarding possible sources of mineral products, both crude and manufactured. Bulletin 599 was issued for the purpose of furnishing to the public in convenient form a summary of the mineral resources available for utilization under the pressure of present conditions, in the hope of encouraging their development and discouraging the importation of raw material and products which can be supplied at home.

**BULLETIN 600.** The Glacier National Park: a popular guide to its geology and scenery, by M. R. Campbell. 1914. 54 pages, 13 plates, 13 text figures.

Describes briefly the geology and scenery of the Glacier National Park, which was set apart by act of Congress in 1910 and includes that part of the Front Range of the Rocky Mountains lying just south of the Canadian line in Teton and Flat-head counties, Mont. Illustrated by a topographic map of the park, diagrams showing geologic features, and halftone plates depicting some of the wonderful scenery to be found and enjoyed there.

**BULLETIN 612.** Guidebook of the western United States, Part B, The Overland Route, with a side trip to Yellowstone Park, by W. T. Lee, R. W. Stone, H. S. Gale, and others. 1915. 244 pages, 29 route maps, 50 plates, 20 text figures.

A handbook for the traveler which deals not only with the geology but with the natural resources, history, and development of the country between Omaha and San Francisco. It shows how differences in scenery and climate depend upon past geologic events and dispels the monotony of the Great Plains by taking the traveler back to times when these regions supported a vegetation very different from their present scanty covering and were inhabited by animals of strange forms and huge size. The scenery of the mountains acquires additional interest from the explanation of the earth movements and the resulting rock structure to which fundamentally the mountain forms are due. Even the desert becomes attractive when the traveler is told of its vanished lakes and is shown the old beach lines which their waves cut in the now arid hillsides.

The book is intended to educate by being interesting, to win hearing for the story of geology by telling it in a clear and simple way, with abundant illustration from the car windows not only of the story itself but of its intimate connection with human life.

The text deals with the route consecutively from east to west and is accompanied by a series of conveniently folded maps and by abundant halftone cuts and diagrams. Matter slightly more technical or detailed than is comprised in the body of the text, although not necessarily less interesting on that account, has been printed as footnotes.

**BULLETIN 620-A.** A gold-platinum-palladium lode in southern Nevada, by Adolph Knopf. 1915. pp. 1-18, Pl. I, fig. 1.

Part of Bulletin 620, "Contributions to economic geology, 1915, Part I." A brief description of the geology of the district surrounding the Boss copper mine, in the Yellow Pine mining district, Clark County, Nev., at which platinum-bearing gold ore was discovered in 1914. The development of the mine and the genesis of the ore are discussed and a review is given of the known lode occurrences of platinum. Great interest attaches to so unusual and remarkable an occurrence of platinum and palladium in a gold-bearing lode. The Boss vein is one of the few primary deposits in which metals of the platinum group occur in more than traces and, with one possible exception (the New Rambler mine in Wyoming), is the only primary deposit of economic importance in which these metals are the constituents of predominant value.

**WATER-SUPPLY PAPER 312.** Surface water supply of the United States, 1911, Part XII, North Pacific coast drainage basins, prepared under the direction of M. O. Leighton by F. F. Henshaw, G. C. Baldwin, G. C. Stevens, and E. S. Fuller. 1915. 706 pages, 4 plates.

Presents briefly the results of measurements of flow made on streams of the north Pacific coast of the United States during the calendar year 1911. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Accuracy, and Cooperation. The book also contains tables giving gage heights and daily and monthly discharges at each station, lithographed maps showing the mean annual precipitation and run-off in the United States, and halftone plates representing typical gaging stations and current meters.

**WATER-SUPPLY PAPER 321.** Surface water supply of the United States, 1912, Part I, North Atlantic coast basins, by C. C. Babb, C. C. Covert, and J. G. Mathers. 1914. 240 pages, 3 plates.

**WATER-SUPPLY PAPER 325.** Surface water supply of the United States, 1912, Part V, Upper Mississippi River and Hudson Bay basins, by A. H. Horton, W. G. Hoyt, and H. J. Jackson. 1914. 193 pages, 2 plates.

**WATER-SUPPLY PAPER 326.** Surface water supply of the United States, 1912, Part VI, Missouri River basin, by W. A. Lamb, Robert Follansbee, and H. D. Padgett. 1914. 375 pages, 2 plates.

**WATER-SUPPLY PAPER 327.** Surface water supply of the United States, 1912, Part VII, Lower Mississippi River basin, by Robert Follansbee. 1914. 84 pages, 2 plates.

**WATER-SUPPLY PAPER 328.** Surface water supply of the United States, 1912, Part VIII, Western Gulf of Mexico basins, by W. W. Follett, Robert Follansbee, and G. A. Gray. 1914. 121 pages, 2 plates.

**WATER-SUPPLY PAPER 329.** Surface water supply of the United States, 1912, Part IX, Colorado River basin, by Robert Follansbee, E. A. Porter, and H. D. Padgett. 1914. 238 pages, 2 plates.

**WATER-SUPPLY PAPER 330.** Surface water supply of the United States, 1912, Part X, The Great Basin, by F. F. Henshaw, E. A. Porter, and G. C. Stevens. 1914. 275 pages, 3 plates.

**WATER-SUPPLY PAPER 331.** Surface water supply of the United States, 1912, Part XI, Pacific coast basins in California, by H. D. McGlashan and G. C. Stevens. 1914. 442 pages, 2 plates.

**WATER-SUPPLY PAPER 332-A.** Surface water supply of the Pacific drainage basins in Washington and upper Columbia River basin, 1912, by F. F. Henshaw and W. A. Lamb. 1915. 282 pages, 2 plates.

**WATER-SUPPLY PAPER 332-C.** Surface water supply of lower Columbia River and Rogue, Umpqua, and Siletz rivers, 1912, by F. F. Henshaw and E. S. Fuller. 1914. 226 pages.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1912. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books also contain tables giving gage heights and daily and monthly discharges at each station, and halftone plates representing typical gaging stations and current meters.

**WATER-SUPPLY PAPER 335.** Geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen. 1914. 365 pages, 6 plates, 17 text figures.

The area discussed in this report embraces 36,317 square miles and includes that part of the Coastal Plain of Texas lying east of Brazos River and south of a line extending east and west through Jefferson, in Marion County. The paper includes a brief description of the geology of this area, with special reference to the underground-water horizons, and discussions of the quality of the water and artesian conditions and prospects in each of the several counties, as well as a geologic map of a part of eastern Texas, maps of several of the artesian reservoirs, maps showing the distribution of timber and the mean annual rainfall and run-off, and diagrams and sections showing ground-water conditions.

**WATER-SUPPLY PAPER 336.** Water resources of Hawaii, 1912, by C. H. Pierce and G. K. Larrison. 1914. 392 pages.

This volume contains results of measurements of the flow of certain streams and ditches in the Territory of Hawaii made during the calendar year 1912.

**WATER-SUPPLY PAPER 338.** Springs of California, by G. A. Waring. 1915. 410 pages, 13 plates, 4 text figures.

As a basis for the discussion of springs and spring waters of California this paper opens with a brief outline of the physical features of the State, together with a few notes on the character of the rocks and their structure, then proceeds to explain the usual or possible composition and properties of most natural waters as well as the source of their constituent substances, and concludes with dis-



cussions of the springs of California classified under the following groups: Hot, carbonated, sulphur, saline, magnesian, iron, artesian, large cold, and minor perennial springs. Accompanying the discussions of many of the springs are analyses of their waters, and at the end of the book are two tables, one of which gives an alphabetic list, by counties, of the best-known springs of the State, with name of owner, location, temperature, and yield, and the other a list of California spring resorts. The illustrations consist of lithologic and topographic maps of the State, showing locations of springs, and photographs of many of the springs and their environs.

**WATER-SUPPLY PAPER 339.** Quality of the surface waters of Washington, by Walton Van Winkle. 1914. 105 pages, 2 plates, 1 text figure.

A brief discussion of the constituents, uses, and purification of natural waters and a detailed consideration, by drainage basins, of the quality of the stream waters of Washington, showing the nature and amount of the material they hold in solution. The book contains many analyses.

**WATER-SUPPLY PAPER 340-C.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part III, Ohio River basin, compiled by B. D. Wood. 1914. pp. i-xxii, 31-42.

**WATER-SUPPLY PAPER 340-D.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part IV, St. Lawrence River basin, compiled by B. D. Wood. 1914. pp. i-xx, 43-52.

**WATER-SUPPLY PAPER 340-E.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part V, Hudson Bay and upper Mississippi River drainage basins, compiled by B. D. Wood. 1914. pp. i-xxi, 53-61.

**WATER-SUPPLY PAPER 340-F.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part VI, Missouri River basin, compiled by B. D. Wood. 1915. pp. i-xxiii, 63-81.

**WATER-SUPPLY PAPER 340-G.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part VII, Lower Mississippi River basin, compiled by B. D. Wood. 1915. pp. i-xxi, 83-93.

**WATER-SUPPLY PAPER 340-H.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part VIII, Western Gulf of Mexico drainage basins, compiled by B. D. Wood. 1915. pp. i-xx, 95-104.

**WATER-SUPPLY PAPER 340-I.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part IX, Colorado River basin, compiled by B. D. Wood. 1915. pp. i-xxiii, 105-116.

**WATER-SUPPLY PAPER 340-J.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part X, The Great Basin, compiled by B. D. Wood. 1915. pp. i-xxi, 117-129.

**WATER-SUPPLY PAPER 340-K.** Stream-gaging stations and publications relating to water resources, 1885-1913, Part XI, Pacific coast basins in California, compiled by B. D. Wood. 1915. pp. i-xxiv, 131-146.

Parts of Water-Supply Paper 340, a directory of Survey stream-gaging stations and publications relating to water resources of the United States. Each part contains a list of all gaging stations maintained in the section named in its title and an annotated list of publications issued by the United States Geological Survey relating specifically to that section, as well as a similar list of reports that are of general interest, covering a wide range of hydrologic subjects, and brief references to reports published by State and other organizations.

Water-Supply Paper 340-C pertains to the Ohio River basin, which includes Ohio River with all its tributaries, the most important being Allegheny, Monongahela, Beaver, Muskingum, New (or Kanawha), Scioto, Miami, Kentucky, Wabash, Cumberland, and Tennessee rivers. These streams drain wholly or in part the

States of Alabama, Georgia, Illinois, Indiana, Kentucky, Mississippi, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia.

Water-Supply Paper 340-D pertains to the United States portion of the St. Lawrence River basin, which includes streams that drain into the Great Lakes and St. Lawrence River from the United States. These streams drain wholly or in part the States of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Vermont, and Wisconsin.

Water-Supply Paper 340-E pertains to the United States portion of the Hudson Bay and upper Mississippi River basins, which include streams (from the United States) whose waters reach Hudson Bay and the Mississippi above its junction with the Ohio (except the Missouri). These streams drain wholly or in part the States of Illinois, Indiana, Iowa, Minnesota, Missouri, Montana, North Dakota, South Dakota, and Wisconsin.

Water-Supply Paper 340-F pertains to the Missouri River basin, which includes Missouri River and all its tributaries, the most important being Jefferson, Madison, Gallatin, Prickly Pear, Little Prickly Pear, Dearborn, Sun, Marias, Judith, Musselshell, Milk, Yellowstone, Little Muddy, Little Missouri, Cheyenne, Niobrara, Platte (including North Platte and South Platte), Kansas, Osage, and Gasconade rivers. These streams drain wholly or in part the States of Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

Water-Supply Paper 340-G pertains to the lower Mississippi River basin, which includes the main stream and all its tributaries below the mouth of the Ohio, the most important tributaries being Meramec, White, Arkansas, Yazoo, Homochitto, and Red rivers. These streams drain wholly or in part the States of Arkansas, Colorado, Kansas, Kentucky, Louisiana, Mississippi, Missouri, New Mexico, Oklahoma, Tennessee, and Texas.

Water-Supply Paper 340-H pertains to the western Gulf of Mexico basins, which include all streams draining into the Gulf of Mexico west of the mouth of the Mississippi and into the Rio Grande. The largest of these streams are the Rio Grande, Sabine, Trinity, and Brazos rivers, Colorado River of Texas, Guadalupe and Chama rivers, Rio Puerco and Pecos River, in the United States, and Rio Salado and Rio San Juan in Mexico, draining wholly or in part the States of Colorado, Louisiana, New Mexico, Texas, and the northern States of Mexico.

Water-Supply Paper 340-I pertains to the Colorado River basin, which includes Green, Grand, Dolores, San Juan, Little Colorado, Virgin, and Gila rivers. These streams drain wholly or in part the States of Arizona, Colorado, Nevada, New Mexico, Utah, and Wyoming.

Water-Supply Paper 340-J pertains to the Great Basin, which is made up of a number of minor basins whose streams do not discharge into the ocean. The largest of these minor basins are the depressions that hold Great Salt Lake, Sevier Lake, Humboldt Sink, Truckee, Walker, Carson, and Owens rivers, and Honey, Mono, Malheur, Harney, Warner, Abert, Summer, and Silver lakes. The streams of this section drain wholly or in part the States of California, Idaho, Nevada, Oregon, and Utah.

Water-Supply Paper 340-K pertains to the Pacific coast basins in California, which include Tia Juana, Sweetwater, San Diego, Bernardo, San Luis Rey, and Los Angeles rivers, draining areas to the south of San Francisco Bay; and San Joaquin, Sacramento, Russian, Eel, Mad, and Klamath rivers, which flow into the ocean through San Francisco Bay or north of it. With the exception of Klamath River and a few streams in Oregon that flow into Goose Lake, at the head of Pit River, all the streams in this division are entirely in California.



**WATER-SUPPLY PAPER 341.** Underground waters of the Coastal Plain of Georgia, by L. W. Stephenson and J. O. Veatch, and a discussion of the quality of the waters, by R. B. Dole. 1915. 539 pages, 21 plates, 4 text figures.

Gives the results of investigations made to determine the composition, structure, and stratigraphic relations of the formations of the Coastal Plain of Georgia and the geologic position, quality, quantity, and economic adaptability of the waters they contain. These topics are discussed first as applicable to the Georgia Coastal Plain as a whole and then as applicable to each county in this geologic province. Mr. Dole, who discusses the quality of the waters, concludes that all the underground waters of this province may be used advantageously for domestic and industrial purposes, although those from the later formations may require a little softening. He thinks also that the surface waters of this section are even better for industrial use than the ground waters, because they are lower in mineral content. The illustrations include a geologic map of the Coastal Plain of Georgia, a map of the underground water resources, a sketch map showing the relation of the drainage to the geologic structure, and halftone plates showing typical formations exposed by railroad cuts.

**WATER-SUPPLY PAPER 342.** Surface water supply of the Yukon-Tanana region, Alaska, by C. E. Ellsworth and R. W. Davenport. 1915. 343 pages, 13 plates, 5 text figures.

Describes briefly the general features of the Yukon-Tanana region, such as the geography, geology, climate, and water supply, and gives an account of the stream-measurement work and the establishment of gaging stations, with an explanation of the methods of carrying on the work and collecting the data. Contains tables showing the daily gage height and discharge of the various streams, and maps and other illustrations showing the hydraulic development of the region.

**WATER-SUPPLY PAPER 343.** Geology and water resources of Tularosa Basin, New Mexico, by O. E. Meinzer and R. F. Hare. 1915. 317 pages, 19 plates, 51 text figures.

Describes the physiography, drainage, and geology of Tularosa Basin, New Mexico, with special reference to its underground water resources and their availability for use in irrigation. Tularosa Basin, which includes about 6,000 square miles of arable land entirely shut in by mountain ranges so that it has no drainage outlets, is dependent upon its scanty rainfall and underground water for the growing of its crops. The paper outlines the routes of travel through the basin, briefly describing the watering places to be found on these routes, and contains analyses of some of the well, spring, and stream waters in this and adjoining areas. The illustrations include maps of the basin and adjacent country showing groundwater conditions, maps showing settlements, diagrams showing precipitation and its relation to altitude and other features, and sections of wells.

**WATER-SUPPLY PAPER 344.** Deschutes River, Oregon, and its utilization, by F. F. Henshaw, J. H. Lewis, and E. J. McCaustland. 1914. 200 pages, 28 plates, 8 text figures.

This report describes the general features of the Deschutes River basin and gives in concise form the results of measurements of stream flow for 1912 at each gaging station. It includes sections on the availability of the water supply, the economic distribution of the water, and the developed and undeveloped water sites, as well as a brief discussion of the old and new laws relating to water (which is necessary for a proper understanding of the water-right situation) and the relation of the Federal Government to the development of water power in this basin. Deschutes River is unique among western rivers in that its natural flow is constant and its headwaters afford reservoir sites so large and so well distributed that the total flow of the river may be utilized both for irrigation and for power. The paper is illustrated by a map of the basin showing the position of the gaging

stations, plans and profiles of Deschutes and Metolius rivers, and maps of many of the power sites. The report was prepared in cooperation with the State of Oregon.

**WATER-SUPPLY PAPER 345-E.** A method of determining the daily discharge of rivers of variable slope, by M. R. Hall, W. E. Hall, and C. H. Pierce. 1914. pp. 53-65, figs. 1-2.

**WATER-SUPPLY PAPER 345-F.** The discharge of Yukon River at Eagle, Alaska, by E. A. Porter and R. W. Davenport. 1914. pp. 67-77, Pls. IV-V, figs. 3-4.

Parts of Water-Supply Paper 345, "Contributions to the hydrology of the United States, 1914."

**WATER-SUPPLY PAPER 345-G.** The water resources of Butte, Montana, by O. E. Meinzer. 1914. pp. 79-125, Pls. VI-VIII, figs. 5-8.

Part of Water-Supply Paper 345. Gives the results of an investigation of the water resources of the small rock-bound basin in the center of which is situated the city of Butte, Mont. The investigation was made in response to an urgent request from the citizens of Butte for information as to the supply of ground water in the flat and the feasibility of developing it for industrial uses and for irrigation. The author concludes that the bedrock in this area forms a nearly water-tight basin but contains small quantities of water near the surface, where the rock is partly disintegrated, and in joints at greater depths. This bedrock will yield enough water in small quantities for domestic use but not enough for irrigation or industrial use. The deposits of clay, sand, and gravel which partly fill the basin are saturated with water below the water table, so that with proper methods of construction a yield of 100 gallons a minute from a single well can probably be developed in most parts of the flat, but flows of large volume should not be expected. The illustrations include a map of the basin discussed, showing water resources, a map of Silverbow Creek near Butte, and a diagram showing average monthly precipitation at Butte.

**WATER-SUPPLY PAPER 345-H.** Ground-water resources of the Niles cone and adjacent areas, California, by W. O. Clark. 1915. pp. 127-168, Pls. IX-XVII, figs. 9-24.

Part of Water-Supply Paper 345. Discusses briefly the physiography, drainage, and origin of ground-water supply of an area comprising the so-called Niles cone (the alluvial fan of Alameda Creek) and adjacent tracts in Santa Clara Valley, Cal., just east of the south end of San Francisco Bay, and describes the geologic formations in relation to ground water. This region is one of intensive farming, dependent on irrigation, and for more than 20 years there has been contention between the farmers and certain water companies that take large supplies from the Niles cone and tributary drainage basins to San Francisco and other cities on the bay. In the investigation resulting in this report an attempt was made to determine the source of the ground water, the quantity now being withdrawn, the amount available, and the area dependent on Alameda Creek. The author concludes that the ground-water supply is hardly adequate for the full irrigation of the area and the present-scale diversions by the water companies. The illustrations include maps of the area, well sections, and graphs showing fluctuations of the water table.

**WATER-SUPPLY PAPER 345-I.** Gazetteer of surface waters of Iowa, by W. G. Hoyt and H. J. Ryan. 1915. pp. 169-221.

Part of Water-Supply Paper 345. Embraces descriptions of all the streams named on the best available maps of Iowa, including the United States Geological Survey's base map of the State, county maps published in the annual report of the Iowa Geological Survey, and the topographic atlas sheets of the United States Geological Survey.

**WATER-SUPPLY PAPER 346.** Profile surveys in the basin of Clark Fork of Columbia River, Montana-Idaho-Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 6 pages, 3 plates.

Describes briefly the general features of the Clark Fork basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. The paper contains plans and profiles showing the fall in the stream and conditions along the bank between Deer Lodge, Mont., and the international boundary.

**WATER-SUPPLY PAPER 347.** Profile surveys in Snake River basin, Idaho, prepared under the direction of R. B. Marshall, chief geographer. 1914. 12 pages, 3 plates.

Describes briefly the general features of the Snake River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. The paper contains plans and profiles showing the fall in the streams and conditions along the banks of Snake River from Enterprise to Minidoka and of Salmon River from Salmon to its junction with Snake River.

**WATER-SUPPLY PAPER 348.** Profile surveys in Hood and Sandy River basins, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pages, 2 plates.

Describes briefly the general features of the Hood and Sandy River basins and gives lists of the gaging stations maintained by the Geological Survey on the two main streams and their tributaries. Contains plans and profiles of Hood River and of Sandy and Zigzag rivers and Camp and Still creeks above Marmot, Oreg.

**WATER-SUPPLY PAPER 349.** Profile surveys in Willamette River basin, Oregon, prepared under the direction of R. B. Marshall, chief geographer. 1915. 9 pages, 3 plates.

Describes briefly the general features of the Willamette River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. Contains plans and profiles of Middle Fork of Willamette River and tributaries, Clackamas and Collawash rivers, and North Fork of Santiam River and tributaries.

**WATER-SUPPLY PAPER 350.** Profile surveys in Bear River basin, Idaho, prepared under the direction of R. B. Marshall, chief geographer. 1915. 7 pages, 1 plate.

Describes briefly the general features of the Bear River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries above the mouth of Logan River. Contains a plan and profile of the river from Riverdale to Navena, Idaho.

**WATER-SUPPLY PAPER 353.** Surface water supply of the United States, 1913, Part III, Ohio River basin, by A. H. Horton, W. E. Hall, and H. J. Jackson. 1915. 264 pages, 5 plates.

**WATER-SUPPLY PAPER 354.** Surface water supply of the United States, 1913, Part IV, St. Lawrence River basin, by C. C. Covert and W. G. Hoyt. 1915. 136 pages, 2 plates.

**WATER-SUPPLY PAPER 356.** Surface water supply of the United States, 1913, Part VI, Missouri River basin. N. C. Grover, chief hydraulic engineer. 1915. 291 pages, 2 plates.

**WATER-SUPPLY PAPER 357.** Surface water supply of the United States, 1913, Part VII, Lower Mississippi River basin, by Robert Follansbee and G. A. Gray. 86 pages, 2 plates.

**WATER-SUPPLY PAPER 358.** Water resources of the Rio Grande basin, 1888-1913, by Robert Follansbee and H. J. Dean, including Surface water supply of the United States, 1913, Part VIII, Western Gulf of Mexico basins, by Robert Follansbee, W. W. Follett, and G. A. Gray. 1915. 724 pages, 3 plates.

These reports present briefly the results of measurements of stream flow made in the drainage basins named during the calendar year 1913 and in the Rio Grande basin during the years 1888 to 1913, inclusive. Data for each gaging station are given under the following headings: Location, Records available, Drainage area, Gage, Channel, Discharge measurements, Artificial control, Winter flow, Accuracy, and Cooperation. The books contain also tables giving gage heights and daily and monthly discharges at each station and halftone plates representing typical gaging stations and current meters. Water-Supply Paper 353 gives, in addition, views of two bridges over Miami River at Hamilton, Ohio, taken during the flood of March-April, 1913, and Water-Supply Paper 358 contains a map of the Rio Grande basin showing the location of gaging stations and mean annual precipitation in New Mexico and Texas.

**WATER-SUPPLY PAPER 363.** Quality of the surface waters of Oregon, by Walton Van Winkle. 1914. 137 pages, 2 plates, 1 text figure.

A brief discussion of the constituents, uses, and purification of natural waters and a detailed consideration, by drainage basins, of the quality of the stream waters of Oregon, showing the nature and amount of the materials they hold in solution. The paper contains many analyses, which show that the river waters of Oregon are low in mineral content and are very good for general industrial use and for irrigation. The report was prepared in cooperation with the State of Oregon.

**WATER-SUPPLY PAPER 364.** Water analyses from the laboratory of the United States Geological Survey, tabulated by F. W. Clarke, chief chemist. 1914. 40 pages.

Contains 203 analyses, made in the chemical laboratory of the United States Geological Survey, of waters from rivers, lakes, wells, and springs in the United States as well as some mine waters. Most of these analyses have been published elsewhere, but many of the original documents are out of print and are therefore obtainable with difficulty.

**WATER-SUPPLY PAPER 365.** Ground water in southeastern Nevada, by Everett Carpenter. 1915. 86 pages, 5 plates, 3 text figures.

Gives an outline of the geography and geology of an arid region comprising about 17,000 square miles in Clark, Lincoln, Nye, and White Pine counties, Nev., and discusses the quality and source of its water supply. The watering places on routes of travel are briefly described and there is a table giving the approximate distances, in miles, between the chief watering places in this section of the State. The illustrations consist of maps of the area discussed, a diagram showing average monthly precipitation at several stations, sections across Spring Mountain, and halftone plates showing types of flowing wells in Las Vegas Valley and other geologic features.

**WATER-SUPPLY PAPER 366.** Profile surveys of Snoqualmie, Sultan, and Skykomish rivers, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pages, 3 plates.

Describes briefly the general features of the Snohomish River basin and gives a list of the gaging stations maintained by the Geological Survey in the area drained by Snoqualmie, Sultan, and Skykomish rivers. Snohomish River is formed by the union of Skykomish and Snoqualmie rivers in the southwestern part of Snohomish County, Wash., and flows northwestward into Puget Sound. The paper contains plans and profiles showing the fall in the stream and conditions along the banks of Snoqualmie River and certain tributaries above Fall City, Sultan River above Sultan, and Skykomish River and certain tributaries above Gold Bar.

**WATER-SUPPLY PAPER 367.** Profile surveys of Missouri River from Great Falls to Three Forks, Mont., prepared under the direction of R. B. Marshall, chief geographer. 1914. 8 pages, 1 plate.

Describes briefly the general features of the Missouri River basin and gives a list of the gaging stations on the main stream in Montana maintained by the Geological Survey. Contains a plan and profile of the river from Great Falls to Three Forks, Mont.

**WATER-SUPPLY PAPER 368.** Profile surveys in Wenatchee River basin, Washington, prepared under the direction of R. B. Marshall, chief geographer. 1914. 7 pages, 1 plate.

Describes briefly the general features of the Wenatchee River basin and gives a list of the gaging stations maintained by the Geological Survey on the main stream and its tributaries. Contains a plan and profile of Wenatchee Lake, Wenatchee River, and certain tributaries.

**WATER-SUPPLY PAPER 375-A.** Ground water for irrigation in the Sacramento Valley, California, by Kirk Bryan. 1915. pp. 1-49, Pls. I-II, figs. 1-6.

Part of Water-Supply Paper 375, "Contributions to the hydrology of the United States, 1915." Describes briefly the geography and geology of Sacramento Valley. The water-bearing formations and the origin, movements, and development of the ground water are discussed, special attention being given to pumping problems. A relief map of northern California, showing outlines of Sacramento Valley, and an outline map of the valley, showing pumping areas and depth to water, as well as diagrams of the fluctuations of the water table at different points in the valley, make up the illustrations.

**WATER-SUPPLY PAPER 375-C.** The relation of stream gaging to the science of hydraulics, by C. H. Pierce and R. W. Davenport. 1915. pp. 77-84.

Part of Water-Supply Paper 375. Considers stream gaging as a branch of hydraulic engineering and concludes that, while a large amount of research is needed before hydraulics can be considered an exact science, yet the recent developments in stream gaging point to the possibility that this branch may in time reach a state of perfection so commensurate with the requirements imposed upon it that all problems connected therewith may be solved with mathematical exactness. When this ideal condition is attained the developments in the science of hydraulics that may be wrought by means of the current meter and the stop watch should be such as to justify the highest expectation of the most enthusiastic stream gager of to-day.

**MINERAL RESOURCES OF THE UNITED STATES, CALENDAR YEAR 1913.** 1914. Part I, Metals, clxxiii+901 pages, 8 text figures; Part II, Nonmetals, vi+1,617 pages, 9 plates, 26 text figures.

Statistics of the production, importation, and exportation of mineral substances in the United States, including accounts of the chief features of mining progress, comparisons of past and present production and conditions, and the application of the products in the useful arts. Contains four inserts showing (1) mineral products of the United States since 1904, (2) clay products of the United States in 1913, (3) production of coal in the United States since 1807, and (4) production of crude petroleum in the world since 1857. A consolidation of 62 advance chapters, each covering a single mining industry or group of allied industries.

**MINERAL RESOURCES OF THE UNITED STATES, CALENDAR YEAR 1914;** parts as follows:

The production of sand-lime brick in 1914, by Jefferson Middleton. 1915. pp. 1-7. Part II: 1.

Potash salts, 1914, by W. C. Phalen. 1915. pp. 9-33, Pl. I. Part II: 2.

The production of fuller's earth in 1914, by Jefferson Middleton. 1915. pp. 35-40. Part II: 3.

The production of phosphate rock in 1914, by W. C. Phalen. 1915. pp. 41-56. Part II: 4.

Fuel briquetting in 1914, by E. W. Parker. 1915. pp. 57-60. Part II: 5.



**GEOLOGIC FOLIO 193.** San Francisco (Cal.), folio, by A. C. Lawson. 1914. 24 folio pages of text, 10 maps, 5 structure-section sheets, 1 columnar-section sheet, 10 plates, 4 text figures. Price, 75 cents.

Description and maps of the San Francisco district, California, comprising the Tamalpais, San Francisco, Concord, San Mateo, and Haywards quadrangles, in Alameda, Contra Costa, Marin, San Francisco, and San Mateo counties. Large parts of four of these quadrangles cover the waters of the Bay of San Francisco or of the adjacent Pacific Ocean. The matter contained in this folio is to be published also in octavo form, price 75 cents.

**GEOLOGIC FOLIO 194.** Van Horn (Tex.) folio, by G. B. Richardson. 1914. 9 folio pages of text, 2 maps, 1 structure-section sheet, 9 plates, 6 text figures. Price, 25 cents.

Description and maps of the Van Horn quadrangle, comprising about 1,019 square miles in El Paso and Culberson counties, Tex.

**GEOLOGIC FOLIO 195.** Belleville-Breese (Ill.) folio, by J. A. Udden and E. W. Shaw. 1915. 13 folio pages of text, 4 maps, 1 columnar-section sheet, 13 text figures. Price, 25 cents.

Description and maps of the Belleville and Breese quadrangles, comprising about 467 square miles in Bond, Clinton, Madison, and St. Clair counties, Ill.

#### TOPOGRAPHIC MAPS as follows:

Alaska (Territory).<sup>1</sup>

Ames, Iowa.

Avena, Cal.

Axial, Colo.

Baldwin, Ill.

Battle Lake, Minn.

Benson, Ariz.

Boring, Oreg.

Burnham, Cal.

Chester, Ill.-Mo.

Chitina, Alaska.<sup>2</sup>

Churubusco, N. Y.

Cincinnati, Ohio-Ky.<sup>3</sup>

Clintwood, Va.-Ky.

Corning, N. Y.

Coshocton, Ohio.

Crawford, W. Va.

Crow Creek, Idaho-Wyo.

Crystal City, Mo.-Ill.

Cuskers, Mont.

Deerwood, Minn.

Douglas, Ariz.

East Cincinnati, Ohio-Ky.<sup>3</sup>

Elkhorn Weir, Cal.

Fredericktown, Ohio.

Gambler, Ohio.

Gillespie, Ill.

Grand Rapids, Mich.

Hereford, Ariz.

Hindman, Ky.

Hominy, Okla.

Hoquiam, Wash.

Houghton, Mich.

Kern River oil field, Cal. (2 sheets).<sup>4</sup>

Kirkville, Cal.

Lanes Creek, Idaho.

Lathrop, Cal.

Little Muddy, Ky.

Longs Peak, Colo.

Loudonville, Ohio.

Macomb, Ill.

Malaga, Wash.

Manteca, Cal.

Marengo, Ohio.

Massachusetts, Rhode Island, and Connecticut (States).<sup>1</sup>

Meadow Creek, W. Va.

Merritt, Cal.

Mesa, Ariz.

Mesa Verde National Park, Colo.

Milford, Pa.-N. Y.-N. J.

Milton, Vt.

Montana (State).<sup>1</sup>

Monument Butte, Colo.

Morenci, Ariz.-N. Mex.<sup>5</sup>

Mount Baker district, Wash.

Mount Morrison, Cal.-Nev.

Mount Olive, Ill.

Mount Rainier National Park, Wash.

Murphy, Tenn.-N. C.<sup>3</sup>

Nemaha, Nebr.-Mo.

Nowata, Okla.<sup>6</sup>

Number Four, N. Y.

Nyack, Mont.

Oregon (State).<sup>1</sup>

Oregon City, Oreg.

Ottawa, Ill.<sup>6</sup>

Palatka, Fla.

Perham, Minn.

Perrysville, Ohio.

Petaluma, Cal.

Peters, Cal.

Pine, Oreg.-Idaho.

Platte County, Mo.

Port Valdez, Alaska.

Pound, Va.-Ky.

<sup>1</sup> Photolithograph.

<sup>2</sup> Reprint of Plate I, Bulletin 374.

<sup>3</sup> New edition; revised in field.

<sup>4</sup> Formerly Oil Center; revised in field and enlarged.

<sup>5</sup> Formerly Boyles.

<sup>6</sup> Resurveyed and reengraved.

Priest Valley, Cal.  
 Reading, Pa.<sup>1</sup>  
 Renault, Ill.-Mo.  
 Ronda, Cal.  
 Roxabell, Ohio.  
 Sago, W. Va.  
 San Francisco and vicinity, Cal.  
 San Francisco Bay (sheet J-10 of world map).  
 Seaford, Del.-Md.  
 Soda Canyon, Colo.  
 Spring Creek, Mont.  
 Sunnyside, Utah.  
 Swinzele, Cal.  
 Todd Lakes, Mont.  
 Troy, Ohio.  
 Tule Valley, Mont.

Underwood, Minn.  
 Union Island, Cal.  
 United States (2-sheet base map).<sup>2</sup>  
 United States (2-sheet contour map).<sup>2</sup>  
 Vergas, Minn.  
 Vermont and New Hampshire (States).<sup>2</sup>  
 Vernalis, Cal.  
 Vincennes, Ind.-Ill.  
 Virginia (State).<sup>2</sup>  
 Walker Creek, Cal.<sup>4</sup>  
 Washington (State).<sup>2</sup>  
 West Cincinnati, Ohio-Ky.<sup>2</sup>  
 Wyoming (State).<sup>2</sup>  
 Yerington district, Nev.  
 Yolo, Cal.

## GEOLOGIC BRANCH.

## SCOPE OF WORK.

The geologic branch is responsible for the geologic work of the Survey. Its original duties, as defined in the act establishing the Survey, were "the classification of the public lands and the examination of the geological structure, mineral resources, and products of the national domain." These duties were at first construed to apply only to the public-land States. Later, however, in order that all parts of the country might share alike in the benefits of its work, the Survey was specifically authorized "to continue the preparation of a geological map of the United States," the scope of its operations being thus made nation-wide. Since that time (1882) the investigations necessary to the fulfillment of the Survey's obligations to the public have become as varied as the aspects of geology itself.

At present the geologic branch is not only the effective agency of the Survey in the geologic investigations carried on by the Government in all parts of the United States and Alaska but also the great geologic information bureau to which the American public, from Key West to Point Barrow and from San Diego to Eastport, applies for knowledge of every sort concerning the earth's crust and its mineral constituents. To the people of this country and, in a surprising degree, to the citizens of other countries, the Survey is the principal source of geologic information regarding not only the geology of the United States and its possessions but also that of Mexico, Central America, and even South America. Through its correspondence it is asked for data regarding the geology and mineral deposits of all parts of the world. The geologic branch has therefore the double task of geologic surveying, including the investigation, description, and mapping of the geology and mineral deposits of all parts of the country, the classification of the public lands, and the publication of the results of

<sup>1</sup> Resurveyed and reengraved.

<sup>2</sup> Revised map; published in new form.

<sup>3</sup> Photolithograph.

<sup>4</sup> Preliminary edition showing part of quadrangle.

<sup>5</sup> New edition; revised in field.



its work on the one hand, and of furnishing to the public miscellaneous geologic information derived from all sources on the other.

#### ADMINISTRATION.

For the more efficient and systematic accomplishment of its work, the geologic branch is organized in four divisions—geology, David White, chief geologist, in charge; Alaskan mineral resources, A. H. Brooks in charge; mineral resources, H. D. McCaskey in charge; chemical and physical researches, G. F. Becker in charge. These divisions, though as nearly autonomous as is practicable without loss of efficiency and strength in the organization as a whole, cooperate effectively. Most of the statistical reports of the division of mineral resources are prepared by members of the division of geology who are specialists in the geology of the respective mineral deposits and whose field investigations give opportunities for close observation of the mineral industries. In paleontologic and other laboratory investigations there is free exchange of assistance between the division of Alaskan mineral resources and the division of geology. Field investigations are occasionally made by members of the division of chemistry and physics under the auspices of the division of geology.

The chief geologist plans the geologic investigations to be carried on by the Survey in the United States and has general supervision of the work. He gives special attention to cooperation in geology with the State surveys and devotes such time as is available to him for field work to field inspections and conferences with geologists and chiefs of sections and to the direction and inspection of the work of the section of eastern fuels.

#### PUBLICATIONS.

The publications of the fiscal year 1915 prepared wholly or partly in the geologic branch embrace 1 monograph, 34 professional papers, bulletins, etc., 92 chapters of reports later published as annual volumes, and 3 geologic folios. Titles and brief abstracts of these publications are given on pages 16–37. Besides the official publications, 56 papers were, with the permission of the Director, published in scientific journals and in the publications of scientific societies. Eight reports, based on work done in cooperation with State geological surveys, have, in accordance with the cooperative agreements, been transmitted to the States for publication. On the other hand, three somewhat extensive geologic reports, prepared by the State organizations under the same agreements, have been submitted for publication by the Federal Survey, and others are in preparation by the States. In the preparation of the reports of mineral production some of the material relating to certain of the industries in the different States is compiled by the State geologists.

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**PUBLIS**

1. The first part of the document is a list of names.

2. The second part of the document is a list of names.

3. The third part of the document is a list of names.

## AREA GEOLOGICALLY SURVEYED IN THE UNITED STATES DURING THE YEAR.

On account of the differences in the nature of the work performed, it is difficult to estimate areas covered by all the geologists in square miles of detailed areal, detailed reconnaissance, and reconnaissance mapping. However, calculations, in which examinations for inspection, paleontologic studies, revision, and local investigations have been omitted, furnish the following results for the fiscal year ended June 30, 1915.

### *Areas covered by geologic surveys, fiscal year 1914-15.*

States east of the one-hundredth meridian:	Square miles.
Detailed areal.....	3, 346
Detailed reconnaissance.....	1, 830
Reconnaissance.....	36, 650
States west of the one-hundredth meridian:	
Detailed areal.....	10, 411
Detailed reconnaissance.....	4, 705
Reconnaissance.....	10, 705
Total in the United States:	
Detailed areal.....	13, 757
Detailed reconnaissance.....	6, 535
Reconnaissance.....	47, 355

The areas in the United States covered by geologic maps published by the Survey and the general nature of the work in each area are shown on Plate I, which does not, however, indicate areas for which reports, prepared by this Survey, have been submitted for publication to cooperating State organizations or to other bureaus and departments of the Federal Government.

The progress of geologic surveying in Alaska is described in the section on the division of Alaskan mineral resources (pp. 92-99).

## DIVISION OF GEOLOGY.

### ORGANIZATION.

The scientific force of the division of geology at the beginning of the year consisted of 66 geologists, 33 associate geologists, 26 assistant geologists, 15 junior geologists, and 22 geologic aids. During the year eight members of the scientific staff resigned to take positions in private life at higher salaries, two members were transferred to the land-classification board, and 12 members were appointed. The total number of geologists of various grades on the staff at the end of the year was 164. Of this number, 81 were employed continuously, 35 gave only part of their time to Survey work, and 48 were not employed.

The division of geology is organized in nine sections, as follows:

1. Section of eastern areal geology (east of the one-hundredth meridian).
2. Section of western areal geology (west of the one-hundredth meridian), including the subsection of investigations in petrology.
3. Section of Coastal Plain investigations.
4. Section of glacial geology.
5. Section of paleontology and stratigraphy.
6. Section of metalliferous deposits.
7. Section of nonmetalliferous deposits.
8. Section of eastern mineral fuels (east of the one-hundredth meridian).
9. Section of western mineral fuels (west of the one-hundredth meridian).

The section of geologic-map editing, although a part of the publication branch, comes under the general supervision of the chief geologist.

#### ALLOTMENTS.

The total funds available for the geologic work of the Survey in the United States for the year 1914-15 were as follows:

Geologic surveys.....	\$400, 000
Statutory salaries.....	13, 700
Search for potash deposits (part of the appropriation for chemistry and physics).....	16, 150
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	429, 850

The allotments of the appropriations were as follows:

Section of eastern areal geology.....	\$24, 700
Section of western areal geology.....	47, 700
Section of Coastal Plain investigations.....	12, 400
Section of glacial geology.....	7, 175
Section of paleontology and stratigraphy.....	23, 500
Section of metalliferous deposits.....	47, 855
Section of nonmetalliferous deposits (including potash).....	38, 750
Section of eastern fuels.....	31, 800
Section of western fuels.....	57, 610
Geologic map editing.....	7, 020
Débris investigation and inspection.....	4, 400
Supervision, administration, salaries of clerical, technical, and skilled labor forces, instruments, supplies, and contingent fund	95, 440
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	398, 350
Land-classification board.....	31, 500

Of the amounts allotted to this division, approximately \$309,900 was expended directly for geologic work, including the search for potash. Of this amount, about \$208,540, or 67.3 per cent, was expended west of the one-hundredth meridian and \$101,375, or 32.7 per cent, east of the one-hundredth meridian. If, however, the \$31,500 for the operations of the land-classification board is included, 70.3 per cent of a total approximating \$341,415 was spent for investigations west of the one-hundredth meridian—that is, essentially in the public-land States. The allotment for supervision, etc., is

divisible in very nearly the same proportions between the eastern and western work.

#### COOPERATION WITH FEDERAL BUREAUS AND STATE SURVEYS.

In strictly geologic field investigations or paleontologic studies the Survey cooperated through the division of geology with 17 States—Georgia, Illinois, Iowa, Kentucky, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, North Dakota, Oklahoma, Oregon, Pennsylvania, Tennessee, Virginia, and Wisconsin. Informal cooperation, without specific financial obligations, exists between most of the other States having geological surveys.

The Survey cooperates with the Bureau of Mines in the metallographic study of ores, in the investigation of the invasion of California oil wells by salt water, in studies of the application of geology to engineering problems of mining and construction, and in the examination of placers and placer mining in the United States. The Survey is also engaged with the Bureau of Standards, the Bureau of Mines, and the Office of Public Roads in a thorough and systematic study of the building stones of the United States. Through the division of geology it also cooperated informally with the Smithsonian Institution, the Bureau of Fisheries, the Forest Service, the Navy Department, the War Department, and the Lighthouse Service, as well as with a number of institutions of learning, including, in particular, the Geophysical Laboratory and Marine Biological Station of the Carnegie Institution. Services varying in extent have, during the year, been rendered to the Department of Agriculture in the examination of lands in the national forests; to the Department of Justice in connection with its suits regarding public lands; to the Navy Department in regard to oil and water supplies; to the Office of Indian Affairs in the classification of Indian lands in Arizona, Washington, New Mexico, and Oklahoma; to the War Department with reference to water supplies in its reservations; and, most important of all, to the General Land Office in the classification of withdrawn coal, oil, and phosphate lands.

The geologic work of the division, both in the field and in the office, is under the immediate supervision of the chiefs of the respective sections, who are directly responsible for maintaining efficiency and a high standard of work. Exceptions are made of the studies of detrital deposition in California, completed by G. K. Gilbert under the joint auspices of the geologic and water-resources branches, the general descriptions by Mr. Gilbert of the structure in the Great Basin region, and the general monographic description of the geology of the Yellowstone National Park, in preparation by Arnold Hague. The work of these distinguished senior geologists of the Survey is reported directly to the chief geologist.

**GENERAL FEATURES OF THE WORK OF THE YEAR.**

The more important scientific and economic investigations in progress in the division of geology were briefly described in the report for last year, pages 34-36, 71-74; this year reference will be made only to those features of the work that may be either new or noteworthy as to progress, as to changed conditions, or as to policy.

The most important item affecting the work of the geologic branch during the year was the increase in the appropriation for geologic surveys from \$300,000 to \$400,000. This was a net addition of but \$65,000 to the funds of the branch, however, for \$35,000 of the new appropriation was required merely to replace the amount which, for several years, had been contributed by the General Land Office to the cost of the Survey work in the classification of the public lands. The net gain in available funds has been used to enlarge the operations of all sections; but the largest proportion, in accordance with the understood spirit of Congress in voting this increase, has been devoted to the classification and valuation of lands in the public domain.

In the search for potash no clue has been neglected. In accordance with plans made the previous year, a deep well was drilled in the season of 1914 near the center of the Black Rock Desert, in western Humboldt County, Nev. Because of the late date (August 1) on which the appropriation bill was passed, the beginning of work was much delayed. However, when once started, the drilling was remarkably free from delay or mishap and on November 16 was completed to a depth of 1,500 feet. The cost of the work as carried out by the Survey with its own equipment was far less than the amount named in the lowest of the bids received for it, all of which were rejected. No bed of potash or other salts, in massive form, was encountered in this well. Nevertheless, the test is not considered conclusive as to the hypothesis that buried saline deposits remain in some of these basins as the result of the drying up of the lakes of Nevada, eastern California, and southern Oregon in Quaternary time. The field to be explored is large, and both the funds and the facilities for exploration have limited the trials to a few localities. The hypothesis on which this exploration, which is in charge of H. S. Gale, has been based deserves further test in the hope that potash-rich salt muds or brines, similar to or more concentrated than those found at Searles Lake, Cal., may be found in other places. In connection with this drilling a study of the sediments composing the beds penetrated by the drill, by the use of the microscope and soil analyses, was begun by M. I. Goldman in order to procure information as to the climatic and other conditions prevailing at different times during the long period in which the lake basin was being filled and converted into a desert. All drill samples containing salts in appreciable quantities were subjected to chemical tests.



The geologic formations which, from the evidence in hand, are regarded as more likely than others to contain buried potash salts in commercial amounts are the Quaternary lake beds in the Great Basin region of the West and the Permo-Triassic red beds of the Rocky Mountain States, Kansas, Oklahoma, and Texas. Whether or not the Quaternary lake province is the one which contains the larger potash-bearing deposits, it would at least appear that the centers of desiccation can be more readily as well as more accurately located in that province and that the drilling adequate for testing can therefore be accomplished with better data for guidance as to locations, with a comparatively small number of deep holes, and at far less cost. The results of exploratory boring in Searles Lake and the shallowly buried salt beds in Death Valley, Cal., establish a degree of validity for the Quaternary lake basin hypothesis and certainly encourage testing in other basins, though it is, of course, quite possible that, on account of geologic conditions not to be detected at the surface of the ground, no other deposits of importance may be present in any other basins. Certain of the basins may safely be condemned on the physiographic and geologic evidence, but beyond the limits of geologic interpretation the question can be determined only by patient search with the drill. A new drilling outfit, specially designed for the work, was purchased in the spring of 1915, supplies were ordered, and other preparations made for drilling at the beginning of the new fiscal year, at localities already selected by Mr. Gale in the Smoke Creek Desert, Nev., which will next be tested.

Studies of the red beds have been carried on in Wyoming, Colorado, Arizona, and New Mexico, in order to define as nearly as possible the basins of sedimentation in Permo-Triassic time and so indirectly, if not directly, to locate the centers of extensive desiccation of the red-bed areas. That there has been desiccation on a great scale in these regions is shown by thick deposits of salt and gypsum in the red beds over large areas. Search is being made for the basins and portions of basins in which saline deposits are the most numerous, as well as thickest, and in which, especially, there may be evidence of the complete drying out of the sea. Samples are gathered, wherever conditions are suitable, for testing in the laboratory. In June the field examinations of the red-bed outcrops in eastern New Mexico was resumed by N. H. Darton, one of the geologists most familiar with the stratigraphy of these formations.

Hope for the discovery of potash deposits in the red beds of the Southwest is encouraged by the detection of slight potash indications in the west-central region and in the Panhandle of Texas. The first of these reported indications was noted at Spurr, in Dickens County, Tex., by Dr. J. A. Udden, of the bureau of economic geology and

technology in the University of Texas, while examining the records and drillings of wells in the Paleozoic regions of Texas, as special agent of this Survey. Subsequent drilling in the region has been investigated, with the discovery of additional traces of potash in the Panhandle, not far from Amarillo, by the State University bureau under the direction of Dr. William B. Phillips.

Evidence warranting boring especially for potash salts by the Government, if not by private parties, at some point in the red-bed region may at any time result either from the geologic examinations now in progress or, as is possibly more likely, from the chance discovery of potash indications or even of a valuable deposit in some well drilled for oil or water. The red beds are very extensive, covering portions of several States in a continuous formation. Pending the conclusions drawn from the geologic studies as to the probable centers of greatest saline deposition in this region, there may be little choice of location throughout large areas. Consequently random locations in untested areas by drillers for oil, gas, or water probably offer, if the drilling is properly conducted with adequate scientific observation, collection of cuttings and brines, and chemical analyses, as good chances for the discovery of potash salts as drill holes located by the Government in advance of the geologic studies. Hence every effort is made to cooperate with all drillers who may be boring in the regions which are under examination or which it is thought may contain large saline deposits. Sample bags and specially prepared log books are furnished to them with the request that cuttings be taken from every "screw," at least in the regions of the formations containing or adjacent to the saline or gypseous deposits. Also samples of brines are solicited. All these samples are tested for potash in the laboratory of the Survey, and the drillers are informed as to whether potash is present in considerable amounts in any of the samples. In the lack of funds sufficient to carry on the exploration more rapidly and especially to conduct boring operations in several areas at once, the effort will be made, whenever possible, to station scientific observers at the sites of new drillings in areas which would appear to be especially promising or in which indications have been reported, in order that the cuttings of the drill may be watched on the ground by a competent observer and tests made of the samples and brines as the work progresses.

It is hoped that drillers for oil and water, not only throughout the red-bed region but in the salt-bearing regions of the Salina and other formations in the Eastern States, may be interested to take advantage of the cooperation of the Geological Survey in the examination of their drill records and cuttings, in order that the possible presence of potash deposits of value in any of these regions may be recognized. In portions of the saliferous areas in the more thickly

settled Eastern States such cooperation by the drillers would easily afford adequate exploration. Wildcat borings in new districts, located in unexplored depositional basins, are of particular importance, and special effort is therefore made to engage the interest of drillers at such points in the examination of their borings by the Survey. There are, however, large areas, especially in the red-bed region, in which no boring is in progress or possibly even contemplated so far as is known to the Survey. In view of the urgent need for the discovery of potash and nitrate supplies within the territory of the United States, it is greatly to be regretted that the funds available for this search are not sufficient to permit exploration on a larger scale through the employment of several drill rigs, operating at once in a number of the relatively favorable regions.

In addition to the explorations above described, the Geological Survey is testing all samples sent to it for examination from reported discoveries of potash salts or nitrates. It has also made field investigations of reported deposits concerning which the tests have been favorable, and the information submitted with the samples has warranted the hope that the deposits might prove to be of value. Many of the samples forwarded contain no potash or nitrates in notable quantities. With few exceptions the deposits have been too lean or, especially the nitrate deposits, too small, though fairly numerous, to be commercially important. A large number of wells, earths, brines, and prospects have been examined in the field, as well as in the office, and considerable attention has been given to the examination of brines from developed salt or bromine producing fields and from the salt-dome oil fields.

In many lines the geologic work of the Survey is showing marked tendency toward greater exactness of method, with corresponding greater definition of results. The exploratory, reconnaissance, and qualitative methods are gradually being supplanted by detailed examinations, and with the more general application of engineering methods the results are in larger measure quantitative. This is most apparent in the work of land classification. In the classification of coal lands, as described in Bulletin 537, the determinations of geologic boundaries of outcrops of coal beds, and of key rocks, as to geographic position, dip, and elevation, are made instrumentally. The economically valuable beds are more frequently prospected and sampled, their variability and continuity are more systematically noted or calculated, and, finally, depths, tonnage, and values are computed. Comparable methods are now employed also in the survey of iron deposits, the examinations for possible oil pools, and the classification of phosphate lands. Gradually and systematically data are being gathered in the different regions for a tonnage estimate of the wealth of the United States in calcium phosphate. The problem of exploiting,

manufacturing, and marketing this priceless endowment of phosphate in such ways as will lead to its larger use by the American farmer is worthy of the most serious consideration. It is an economic misfortune and a reproach that so large a proportion of the phosphate rock (35 per cent of the total production of 2,734,043 tons in 1914) now mined in this country is shipped abroad to enrich the soils of foreign countries while the soils of the United States are in general becoming slowly impoverished. With a rapidly increasing urban population to be fed, we are confronted by a waning crop production to the acre, and, in the end, by an adverse balance of foreign trade that must be met by a gradual sacrifice of our unreplaceable mineral resources, either in manufactured forms or in the raw state, instead of by products of the soil that may be renewed without exhaustion of the source.

To supply the need for general information, accurate though condensed, as to the coal fields of the country, descriptive summaries, with maps, similar in some respects to those published in the Twenty-second Annual Report of this Survey, are being prepared for issue as parts of a general report on the coal fields of the United States, under the supervision of M. R. Campbell. In this report, for which there is a constant and large demand, the coal resources of the many fields will be differentiated and, with additional and more precise data than have hitherto been available, will be recalculated quantitatively in revision of the estimates by Mr. Campbell printed in Mineral Resources for 1907 and of those later prepared by the Survey for publication in "Coal resources of the world," under the auspices of the International Geological Congress which met in Toronto, Canada, in 1913.

Comparable in some respects to the engineering and quantitative methods of investigation applied to some of the nonmetalliferous and fuel deposits is the systematic study of the metalliferous deposits by natural provinces or by large geographic units, such as States. Comprehensive and systematic studies like those of the mining districts of Utah, by B. S. Butler, or of Idaho, by J. B. Umpleby, both now in progress under the direction of F. L. Ransome, can not fail to give a better knowledge of the general conditions of occurrence and modes of association of the different ores, the origin and characteristics of the deposits, and their limitations and adaptations with reference to different treatments. Nevertheless, such more comprehensive investigations can not relieve the Survey of the necessity for reconnaissance examinations of newly discovered or newly developing districts and for the special study of the geology of deposits which present new or unusual features and of those which, though not now valuable, may hereafter become so.

The progress of knowledge as to the origin of metalliferous deposits, a line of early geologic inquiry, is marked possibly more strongly than ever by a broadening of the methods of investigation. This is shown in the increasing diversity of the researches in geology, chemistry, and physics contributory to the solution of the problem. The studies of the enrichment of ore deposits demand, among other things, the understanding of paleogeographic conditions, the interpretation of geologic history, and the paleontologic determination of the time elements concerned. More observations must be made of the influence of various minerals on the deposition of metals, such as silver, or of other minerals, from solution, as is shown by E. S. Bastin and Chase Palmer in their studies of silver enrichment. Further, the metallographic microscope, with its photographic attachment, supplements the petrologic microscope and chemical methods in the differentiation of the opaque minerals and the study of their mode of association and their origin. By this means supposed chemical compounds have been shown to be mere mixtures of minerals, and relations previously unsuspected or unproved have been discovered. Inasmuch as the metallographic study of the relations and mode of association of the individual minerals in composite ores promises to give aid in separating and reducing such ores, as well as in solving the problems regarding the origin of the ores, this study is recognized as of direct and mutual concern both to the Geological Survey and to the Bureau of Mines. Accordingly, the work of F. B. Laney is carried on under the joint auspices of the two bureaus. That part of the investigation which concerns the genesis of the ores and their deposition falls naturally within the province of the Geological Survey, while the application of the ascertained facts concerning the genesis of the ore minerals, their association in the rock, and their mechanical differentiation is to be made by the Bureau of Mines in the solution of problems of successful treatment and utilization. In these studies biochemistry also must be considered, as it is in the study of the deposition of iron oxide by E. C. Harder.

Another inquiry that may have far-reaching significance with reference to the occurrence and relations of metals and other substances as now found in the earth is illustrated by the experiments made by C. E. Van Orstrand on the diffusion of solids, which are more fully mentioned in the account of the work of the division of chemistry and physics.

Recognizing that the ability to form a correct judgment as to the practical utilization and value of an ore or other mineral deposit in the ground is most effectively acquired through the field observation of operating works and processes for the exploitation and reduction of the same or similar deposits, the Survey regards it of the highest



importance that the geologist who may be called upon to appraise undeveloped mineral resources in the public domain or in other regions of the country shall keep as closely as practicable in touch with the mineral industry, and shall have a knowledge of the factors conditioning the successful treatment and utilization of the ores he is examining. In the acquisition of this necessary special knowledge of mineral deposits of a certain type and of the industry based on that type, the record of the production of that industry is, so to speak, a by-product of the estimate of the deposits and the study of the processes. Accordingly, it is found not only that the reports of mineral production in the United States can be most satisfactorily as well as economically prepared by the geologist who has specialized in the particular lines of economic geology, but also that the geologist becomes thereby better qualified for his field investigations and for service to the increasing number of applicants to the Survey for data, otherwise not obtainable, concerning ore deposits and their utilization, the marketing of ores, or the obtainment of minerals or mined products. It thus happens that the geologist may be reporting the mineral production on the one hand, while he may at the same time on the other hand be taking, perhaps on a quantitative basis, a census of the country's undeveloped reserves.

The great damage to certain oil fields, especially in California, through the entrance of water into the oil-producing sands, with the result that large quantities of oil can never be extracted, has made it necessary for the Government, as one of the large landholders in the region, to take part in the investigation of the causes and in the means for prevention. Accordingly, late in the fiscal year 1914 the Bureau of Mines and the Geological Survey jointly undertook the examination of the problem, in which the Survey has been studying the conditions of the association of water, oil, and gas in the sands, and their modes of migration with special special reference to the mechanical constitution, chemical composition, and attitude of the beds. The methods of remedying the evil and the engineering devices for conserving the oil are receiving consideration from the Bureau of Mines. The investigations conducted by the Survey are far reaching, touching even the problems of the origin of oil and gas, and may not be concluded without prolonged studies in many fields; but all the oil and gas geologists of the Survey are deeply interested in the inquiry, and it is certain that their combined researches will lead to a better understanding of the laws of the occurrence and movements of oil. Meanwhile the data relating immediately to the causes of the local damage in California are being assembled in the form of a report.

The general reconnaissance survey of the geologic formations, paleontology, and underground-water supplies of the Atlantic and

Gulf Coastal Plain has reached an advanced stage. This work, which has for a number of years been in progress under the direction of T. Wayland Vaughan, has, quite aside from its important economic products, contributed in a most invaluable way to the knowledge of the stratigraphy and geologic history, not only of this great area of the United States but of all southern North America and Central America. A part of the general problem now receiving much attention concerns the correlation of the Pleistocene terraces from region to region and from the Coastal Plain into the glaciated regions, in the effort to connect, so far as possible, the Quaternary history and physiography of the Coastal Plain regions with the glacial stages and deposits to the north.

Conclusions that are essentially by-products of the main investigations just cited are illustrated by the results of Mr. Vaughan's researches regarding the coral-reef plateaus and the continental shelf in the Antillean region and the origin of oolites and calcareous deposits, or of the studies by E. W. Shaw of the fluvial and estuarine deposition of sediments. Investigations like Mr. Shaw's are immediately applicable to such studies as the examination of the borings made in the course of potash exploration in Nevada.

Looking forward to the day when the oil and gas resources of the United States will have become depleted, the Geological Survey is giving some attention to the carbonaceous shales of the United States and their capacity to yield petroleum, gas, and other valuable distillates. The examinations of the hydrocarbon shales in the Green River formations of Colorado and Utah are described on page 61, and preliminary statements of the results of the investigations will be published at an early date. Some experimental tests have also been made of the carbonaceous shales of Devonian age in the Eastern States and of the cannel coals and the richly carbonaceous shales associated with other coals in these States. Field tests are made by a portable apparatus carried from camp to camp. The laboratory distillations and fractional separations are performed by the Bureau of Mines.

The most important of the new cooperative projects organized within the year is that for the comprehensive study of the placer deposits of the United States. Preliminary work in accordance with this plan, which was initiated by the Geological Survey, was done by J. M. Hill, who is considering the character, geologic occurrence, and origin of the deposits. The contribution by the Bureau of Mines will relate to methods and costs of placer mining and will be made by Charles Janin, a mining engineer of that bureau. It is expected that the field work will extend over two or more field seasons.



The foregoing sketch of some of the features of the work of the division of geology that appear to be noteworthy does not include some of the most important scientific work, which is too well known to require special comment.

#### SCOPE OF THE WORK OF THE SECTIONS.

The work of the several sections of the division of geology is briefly outlined in the following synopsis:

1. The section of eastern areal geology—Arthur Keith, geologist in charge—conducts reconnaissance and detailed work in areal or general geology in regions east of the one-hundredth meridian, the primary object of which is to make known, mainly through folios of the Geologic Atlas, the general geology of the region studied, or to prepare scientific and educational descriptions of it, rather than to examine and describe or map the area especially on account of some geologic problem or some particular economic resource. The work of this section is carried on in close cooperation with several State surveys and university departments of geology, an effort being made to coordinate the work of all participants. During the year the operations of the section have covered areas in Alabama, Arkansas, Delaware, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Vermont, and Virginia.

2. The work of the section of western areal geology (west of the one-hundredth meridian)—F. L. Ransome, geologist in charge—corresponds to that of the section of eastern areal geology and is similar in scope, these sections being especially charged with the preparation of the folios of the Geologic Atlas of the United States.

Four geologic railway guides, designed primarily for the benefit of travelers to the Panama-Pacific Exposition, have been prepared under the general auspices of this section. Field work was begun by six geologists early in June, 1914, and was continued into the autumn. One of the four resulting bulletins (Bulletin 612) has already appeared and is described on page 27.<sup>1</sup> The activities of the section have concerned the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oklahoma, Oregon, South Dakota, Utah, and Washington.

3. The section of Coastal Plain investigations—T. Wayland Vaughan, geologist in charge—is occupied primarily with the study of the numerous geologic formations of the Atlantic and Gulf Coastal Plain, their character, extent, general structure, correlations, conditions of deposition, and geologic history, and especially of the underground-water resources of the region. Incidental attention is given to other mineral resources which are more particularly consid-

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<sup>1</sup> The other bulletins of this series have been published since the close of the fiscal year.

ered by other sections. Because of their importance in accurately tracing the different geologic formations and in supplying a reliable basis for geologic correlation, the fossil organisms entombed in the different formations are carefully studied. Most of the areal work of this section during the year has been of the reconnaissance type. Its office investigations are comprehensive and broadly scientific, as well as economic. The National Museum, the Bureau of Fisheries, the Carnegie Institution, and a number of specialists in biology or paleontology, as well as the division of underground waters of the water-resources branch, have cooperated with or contributed to the work of this section.

Investigations have been carried on by this section during the year in Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, North Carolina, Rhode Island, South Carolina, Tennessee, Texas, and Virginia.

4. The section of glacial geology—W. C. Alden, geologist in charge—is engaged in the study of the work of glaciers, the glacial and interglacial deposits and the contemporary deposits of the bordering regions, and the geologic history of the continent during the Quaternary period. The geologists occupied with these varied and specialized problems are charged with the classification and mapping of the Quaternary deposits of the glaciated regions. The work of this section during the year has comprised field studies and mapping and the preparation of reports covering areas in Illinois, Indiana, Iowa, Massachusetts, Michigan, Minnesota, New York, North Dakota, Vermont, and Wisconsin.

5. The section of paleontology and stratigraphy—T. W. Stanton, geologist in charge—is responsible for the determination of the relative age and equivalence of the strata in different areas and for the reference of the formations to a geologic time scale. The examination of current collections of fossils and the preparation of reports on them for the use of geologists engaged in areal mapping and special investigations occupy a large proportion of the time of the paleontologists. The geologists who specialize in paleontology are engaged also in working out the sequence and character of the continental changes, the physiographic and climatic conditions of the various periods, and the history of the animal and plant life of the geologic epochs. The field study of the stratigraphic distribution of the fossil floras and faunas gives the most complete key to the correlation of the beds; hence the paleontologists can most efficiently accomplish their work by close cooperation with the areal and economic geologists. The work of this section is practically coextensive with that of the divisions of geology and of Alaskan mineral resources and is indispensable to the geologic mapping of the areas surveyed and the satisfactory determination of the structure. The States receiving most

attention from this section during the year were Alabama, Arkansas, Colorado, Florida, Georgia, Idaho, Indiana, Kentucky, Maine, Maryland, Missouri, Montana, North Dakota, Oklahoma, South Dakota, Tennessee, Virginia, Wisconsin, and Wyoming.

6. The section of metalliferous deposits—F. L. Ransome, geologist in charge—not only studies metalliferous deposits and mines and investigates the conditions and methods of ore deposition, but also carries on reconnaissance geologic examinations of many new districts and makes complete detailed areal surveys, for folio publication, of quadrangles in which metalliferous deposits are of special importance, the folios being subject to the inspection and approval of the geologists in charge of areal geology. The geologists of the section have been engaged on projects in Alabama, Arizona, California, Colorado, Georgia, Idaho, Kansas, Louisiana, Minnesota, Missouri, Montana, Nevada, New Mexico, Oklahoma, Oregon, Tennessee, Texas, Utah, Washington, and Wyoming.

7. The section of nonmetalliferous deposits—Hoyt S. Gale, geologist in charge—is concerned with the study of the deposits of non-metallic ores and minerals, exclusive of fuels, and with the geologic investigation and mapping of regions in which such minerals or deposits are of paramount importance. During the year the greater part of the work of the section has been divided between the search for potash in commercial quantities in the salts of the old evaporation basins or dried-up ancient lakes of the Southwest and the classification of the phosphate-bearing lands withdrawn from entry in Idaho and Wyoming. Special investigations relating to clays, building stones, the eastern phosphate fields, and mica have also been carried on. The work in this section relates in particular to Alabama, California, Colorado, Connecticut, Georgia, Idaho, Kentucky, Massachusetts, Maryland, Minnesota, Nevada, New Hampshire, New Mexico, New York, North Carolina, Ohio, Oregon, Tennessee, Texas, Utah, Virginia, West Virginia, and Wyoming.

8. The section of eastern fuels—David White, geologist in charge—conducts examinations of areas east of the one-hundredth meridian containing coal, oil, or gas. It not only investigates and describes the economic geology, but in some regions also works out the detailed areal geology for folio publication, the folios being subject to the inspection and approval of the geologist in charge of the section of eastern areal geology. The work of the section during the year has been conducted in cooperation with the State surveys of Illinois, Missouri, Minnesota, Oklahoma, Pennsylvania, Tennessee, and Virginia. Noncooperative work has been done in Arkansas, Georgia, Indiana, Iowa, Kansas, Louisiana, Mississippi, Ohio, Texas, and West Virginia.

9. The section of western fuels—M. R. Campbell, geologist in charge—conducts examinations and surveys in the fuel-bearing areas west of the one-hundredth meridian similar to those carried on by the section of eastern fuels. The greater part of the work of the western section has consisted in classifying and mapping coal or oil bearing lands of the public domain in California, Colorado, Montana, New Mexico, North Dakota, Oregon, Utah, and Wyoming, but a part of the work in this section was done in quadrangle units for folio publication, subject to the approval of the geologist in charge of the section of western areal geology.

The section of geologic-map editing—G. W. Stose, geologist in charge—is a part of the publication branch, but its work is so intimately associated with the work of the individual geologists in the division of geology that it is administered as a part of the geologic branch, in which the chief of the section is an active geologist. The geologic field investigations made by Mr. Stose are reported in the work of the sections to which they pertain.

#### ASSISTANCE TO OTHER DIVISIONS.

In addition to performing work in their respective sections, a considerable number of the geologists in the sections of metalliferous and nonmetalliferous deposits and several geologists in the sections of eastern and western areal geology have prepared for publication, in the annual volumes of Mineral Resources, reports on the production and statements of the industrial conditions relating to a large number of mineral resources with which they are especially familiar. Parts of the salaries of some of these geologists are paid from the funds of the division of mineral resources, and the traveling and field expenses incurred by others in the collection of data are also paid from the funds of that division.

A number of economic geologists of this division serve as members of the special committees of the land-classification board. The paleontologists of the division report on fossils collected for the division of Alaskan mineral resources and are called upon to classify fossils for the National Museum and, through courtesy, occasionally for foreign governments and other scientific institutions.

Close cooperation, with constant interchange of information, exists between the geologic branch and the water-resources branch in the investigation of underground-water movements and supplies and of sedimentary deposition. Members of the land-classification board serve in the geologic field parties.

#### COMMITTEE ON GEOLOGIC NAMES.

The committee on geologic names is a standing committee of the geologic branch, consisting of T. W. Stanton (chairman), M. R. Campbell (vice chairman), W. C. Alden, G. H. Ashley, Arthur Keith, F. L.

Ransome, G. W. Stose, and David White. The minutes and other records are kept by the secretary, Miss M. G. Wilmarth, who also scrutinizes the geologic nomenclature and classification used in all manuscripts submitted for publication and prepares data on them for consideration by the committee. During the year 175 manuscripts, comprising 19,425 pages and involving about 3,643 geologic names, have been examined.

To meet the needs of the Survey geologists, as well as a strong demand from professional geologists in general, the work of compiling correlation charts and a stratigraphic lexicon of geologic formations in the United States and Alaska, in form for publication as bulletins, has been begun. The committee has invited the advice and cooperation of over 200 American geologists in the consideration of general questions relating to the revision of the classification and the nomenclature of North American geologic formations.

#### GENERAL SUMMARY.

Geologic investigations were continued in 47 States by a force of 164 geologists. Systematic detailed surveys of mining districts were carried on in Arizona, Colorado, Minnesota, Nevada, New Mexico, Oklahoma, Oregon, and Utah. Reconnaissance studies of mining districts were made in Arizona, California, Colorado, Idaho, Kentucky, Montana, Nevada, New Mexico, North Carolina, Oregon, Tennessee, Utah, and Wyoming, and general and detailed geologic and paleontologic work was continued in all parts of the country, including a large amount of geologic work in the coal and oil fields, especially in the public-land States, where also the search for commercial deposits of potash and nitrates was continued. Cooperative geologic work was carried on with the State geological surveys of 17 States, also with the Bureau of Mines, Bureau of Standards, Office of Public Roads, Bureau of Fisheries, Forest Service, Smithsonian Institution, Lighthouse Service, Geophysical Laboratory of the Carnegie Institution and the marine biologic station at Dry Tortugas.

Among the geologic investigations not relating to any particular region mention may be made (1) of the extension of the studies of sulphide enrichment, by W. H. Emmons, who has submitted a revised and greatly enlarged text replacing Bulletin 529 on this subject; and (2) of the investigation by David White into the origin of coal and petroleum and the development of the different classes of these fuels. The origin and the conditions of occurrence of oils of successively higher grades, and some conditions precluding the occurrence of oils in different regions are discussed in an address by Mr. White before the Washington Academy of Sciences and printed in the Journal of the Academy for March 19. A general paper on the origin of coal, prepared by Mr. White several years ago for



publication by the Bureau of Mines, has been printed in Bulletin 38 of that bureau.

#### WORK OF THE DIVISION BY STATES AND COUNTRIES.

The work of the division of geology during the year was done in 47 States, the Canal Zone, the Antilles, and the Hawaiian Islands.

##### ALABAMA.

The upper Eocene and Oligocene formations of Alabama have been thoroughly studied by C. Wythe Cooke, whose stratigraphic correlations have been transmitted for publication by the Survey as Professional Paper 95-I, "The age of the Ocala limestone." Mr. Cooke has in preparation also a preliminary account of the stratigraphy of the St. Stephens limestone.

Two manuscripts, one on the Catahoula formation and the other on the Pliocene of the Gulf Coastal Plain, have been submitted by G. C. Matson and E. W. Berry, Mr. Matson writing the stratigraphic descriptions and Mr. Berry the paleontologic descriptions and correlations, based on the study of the fossil plants. Mr. Berry has in preparation also a report on the fossil flora of the Claiborne group.

For the better definition and correlation of several of the formations to be described and mapped in the Bessemer-Vandiver and Montevallo-Columbiana folios, additional field examinations were made by Charles Butts, partly in conference with E. O. Ulrich, in the vicinity of Pelham and in the Shades Valley southeast of Bessemer. Paleontologic data for correlations in other regions of the State were collected by R. D. Mesler from the earlier Paleozoic formations.

In accordance with an informal cooperative agreement between the State geologists of a number of the Mississippi Valley States and the Federal Survey for the purpose of better differentiating the Mississippian formations and establishing correlations between different regions of the Mississippi, Ohio, Tennessee, and Appalachian valleys, the Carboniferous rocks of the Mississippian section near Huntsville were studied by G. H. Girty, with the object of collecting invertebrate fossils and making correlations.

The mica deposits in Randolph, Clay, Tallapoosa, and Coosa counties were examined by D. B. Sterrett, who has nearly completed the field work for a report on mica in Alabama.

A little field work was done on the red iron ores of northeastern Alabama by E. F. Burchard.

##### ARIZONA.

The quicksilver deposits of the Mazatzal Mountains, covering an area of about 20 square miles, were examined by F. L. Ransome, who submitted a brief report thereon (Bulletin 620-F). Mr. Ransome

also made a geologic reconnaissance of the Sierra Ancha and paid short visits to the Ray and Miami mining districts for the purpose of collecting supplementary specimens and data for his economic report on these districts. A brief paper on the Paleozoic section in the Ray quadrangle was published by Mr. Ransome in an unofficial periodical.

A report on the mineral deposits of the Santa Rita and Patagonia Mountains by F. C. Schrader was published as Bulletin 582.

A detailed examination of the Colorado River and Yuma Indian reservations, primarily for purposes of classification, was made at the request of the Office of Indian Affairs. Some of the results of this work, which was done by E. L. Jones, jr., were embodied in a paper on the placer deposits near Quartzsite (Bulletin 620-C). Mr. Jones also prepared a brief report on a reconnaissance covering perhaps 60 square miles in the Kofa Mountains (Bulletin 620-H) and has in preparation a short report on the Dos Cabezas mining district, the field work for which was done during the previous season. A preliminary draft of the Tucson folio, on which C. F. Tolman, jr., has been engaged, was submitted by him, but further field work is necessary before the text and maps will be ready for publication.

A report on the Shinumo quadrangle, in the Grand Canyon district, by L. F. Noble, appeared as Bulletin 549. Further studies of Grand Canyon geology are being prosecuted by Mr. Noble, chiefly at his own expense.

The detailed areal and economic survey of the geology of the Winkelman quadrangle has been begun by C. H. Clapp, who has mapped 173 square miles.

A reconnaissance report on northeastern Arizona and northwestern New Mexico, based on several years of field examinations by H. E. Gregory, has been nearly completed. Field work in this region is now in progress.

In connection with the preparation of the guidebook to the region along the Santa Fe Route, from Kansas City to Los Angeles, field examinations were made at a number of points in Arizona.

At the request of the Department of Agriculture an examination of some mining claims in the Grand Canyon was made by H. G. Ferguson, whose preliminary report has been transmitted to the Secretary of the Interior.

#### ARKANSAS.

A study of the recent geologic history in the vicinity of Moon Lake for the Department of Justice, by E. W. Shaw, has resulted in interesting observations on the processes and effects of erosion and sedimentation, which will be incorporated in Mr. Shaw's report on the Mississippi embayment.

The fossil floras of the Jackson and Claiborne groups in Arkansas are now being studied by E. W. Berry. The results of this work



will be important not only in correlations between other areas and Arkansas but in contributing to knowledge of the extinct floras of the earlier Tertiary in southern North America.

Short examinations, necessary for the correlation of the formations of the Hot Springs, Caddo Gap, and DeQueen quadrangles, were made by H. D. Miser. The Hot Springs folio is well advanced toward completion and the manuscript for the Caddo Gap-DeQueen folio is progressing satisfactorily.

A folio covering the Harrison and Eureka Springs quadrangles was completed by H. D. Miser and A. H. Purdue and has been submitted for publication.

The gypsum deposits of Arkansas have been described by Mr. Miser for publication in the revised edition of Bulletin 223. Mr. Miser also furnished the Arkansas data for use in the revision of Bulletin 585, "Useful minerals of the United States."

Water-Supply Paper 399, "Geology and underground waters of northeastern Arkansas," by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the water by R. B. Dole, has been revised and is now in the hands of the editor.

The asphalt deposits near Mena were examined by C. H. Wegemann. These deposits are interesting mainly because of the advanced carbonization of the hydrocarbon substance, which appears to have suffered alteration.

The Carboniferous faunas of Arkansas have been described by G. H. Girty in Bulletins 593, 595, and 598, in press at the close of the fiscal year.

#### CALIFORNIA.

A review of the deposits of salt, soda, borax, and potash at Searles Lake, San Bernardino County, was made by H. S. Gale, and a report on these deposits was issued as Bulletin 580-L. A brief report on the Amargosa nitrate area, in Inyo County, by Mr. Gale, was transmitted to the War Department, at whose request the examination was made.

Studies of the petroleum resources of the State were continued by R. W. Pack, G. S. Rogers, and W. A. English, and the investigation of the Sunset-Midway field was completed, special attention being given to the underground conditions as revealed by the drill records, in order to discover, if possible, the laws governing the accumulation of oil and gas and particularly the relation of productive pools to geologic structure and to water. A detailed resurvey, including about 300 square miles, was made of the areal geology in this field and the surrounding areas, the description of which, mainly by Mr. Pack, is now in preparation. Special attention was given by Mr. Rogers to the conditions of water movement and invasion. In prosecuting this

work he made a close study of the geologic structure and of the history and behavior of the wells. In the determination of local structure, as well as in the consideration of the water problem, Mr. Rogers contributed to the investigation of the general geology of the region.

Ralph Arnold, formerly of this Survey, assisted by J. R. Pemberton, spent 10 days in field revision of the geologic map of the Ventura quadrangle.

A detailed examination of the stratigraphy and structure of undrilled areas in Cuyama Valley, aggregating about 400 square miles, was made by W. A. English, under the general supervision of R. W. Pack, in order to determine their probable oil prospects. A report on these areas has been prepared and submitted for publication.

A report by Robert Anderson and R. W. Pack, on the geology and oil prospects along the western border of the San Joaquin Valley north of Coalinga, is now in press as Bulletin 603.

Studies in Yosemite National Park were continued by F. E. Matthes and F. C. Calkins. Mr. Calkins mapped in detail the igneous rocks of part of the tract represented by the special map of the Yosemite Valley. Mr. Matthes continued and nearly completed the physiographic study, including the detailed mapping of the moraines, of the upper Merced basin and of some adjacent ground. Messrs. Matthes and Calkins are collaborating in a popular account of the geology of the Yosemite region, which is designed primarily to give a comprehensive and scientifically exact yet readable explanation of the sculpture of the region but deals with all aspects of the geology. Mr. Matthes writes of the general geologic history and the work of streams and glaciers, and Mr. Calkins contributes an account of the hard rocks, whose distribution greatly influences the character of the sculpture.

The results of the detailed study of the Weaverville quadrangle are in preparation by J. S. Diller and H. G. Ferguson for issue in a folio.

A report on the lode deposits of the Allegheny district by Mr. Ferguson was published as Bulletin 580-I and a paper on the pocket gold deposits of the Klamath Mountains, also by Mr. Ferguson, was prepared for unofficial publication.

Lassen Peak, which was visited in June, 1914, and again in the autumn of that year by Mr. Diller while he was gathering data for the guidebook covering the Shasta Route and Coast Line (Bulletin 614) was revisited by him in June, 1915, for the purpose of studying the phenomena of the only active volcano in the United States (exclusive of Alaska), with a view to the preparation of an educational bulletin describing and illustrating Lassen Peak, its history and present changes, and its volcanic action as a whole.

A report on the geology of the east slope of the Sierra Nevada overlooking Owens Valley has been practically completed by Adolph

Knopf, who in the summer of 1914 made a preliminary field examination of the Mother Lode district in preparation for a thorough study of that district during the season of 1915-16.

A report on some mining districts in northeastern California and northwestern Nevada (Bulletin 594), by J. M. Hill, was issued during the year.

A portion of the Rock Creek quadrangle was mapped in detail by L. F. Noble for folio publication.

An area lying between latitude  $34^{\circ} 30'$  and the Mexican boundary has been covered by a reconnaissance examination by R. T. Hill, who, after mapping about 4,000 square miles on a scale of 1:250,000, is now preparing a report on this region.

The report on the copper deposits of Shasta County, by L. C. Graton, the preparation of which has long been postponed in consequence of Mr. Graton's resignation from the Survey, is now well advanced, though Mr. Graton expects to make additional field revision during the coming year before the report is submitted for publication.

#### COLORADO.

The survey of the volcanic area of the San Juan Mountains was continued by Whitman Cross, assisted by E. S. Larsen, jr., and J. Fred Hunter, jr., but in accordance with the plan adopted in 1913 to complete the study of the great volcanic complex of these mountains as speedily as possible, the work was all of reconnaissance character. Of the 1,020 square miles examined in the northeastern portion of the mountains, 650 square miles were covered in reconnaissance and 370 miles in semidetail. In the area south of Tomichi Creek and Marshall Pass and west of the San Luis Valley, in the Cochetopa and Saguache quadrangles, it was found impossible to maintain the standard of geologic mapping followed in other regions, on account of the inadequacy of the Hayden topographic map and other maps available for the delineation of geologic details. A greater measure of success was achieved in the Creede quadrangle, of which a new topographic map was available. A report covering the season's field work is in preparation by Messrs. Cross and Hunter, and Mr. Cross was also engaged on a general report on the geology of the entire San Juan area. A paper describing the pre-Cambrian rocks along Gunnison River was prepared by Mr. Hunter.

The Pleistocene deposits in the San Juan Mountains (Montrose quadrangle) were studied by W. W. Atwood, assisted by Kirtley Mather. A report by Mr. Atwood, describing an extremely interesting glacial deposit of Eocene age in southwestern Colorado, has recently been published as Professional Paper 95-B.

A detailed report on the economic geology of Gilpin County and adjacent portions of Clear Creek and Boulder counties, embracing

the Central City district, by E. S. Bastin and J. M. Hill, has been transmitted for publication. A description of the ores of Gilpin County by Mr. Bastin and a paper by Mr. Bastin and Chase Palmer on the precipitative action of metallic minerals upon silver in solution have been printed in unofficial publications. Mr. Bastin also prepared a paper on the geology of the pitchblende ores of Colorado (Professional Paper 90-A).

A report on the Creede district by E. S. Larsen, jr., and W. H. Emmons is now nearing completion, that portion of the manuscript by Mr. Emmons having already been transmitted.

For the monograph on the Leadville district, in preparation by J. D. Irving, a chapter on the oxidized zinc ores has been submitted by G. F. Loughlin, and F. B. Laney is preparing a chapter on the microstructure of the ores.

Brief investigations of reported nitrate occurrences in Colorado were made by M. I. Goldman, who has reviewed in the office the somewhat voluminous literature on the subject of soil nitrates in Colorado and Utah with a view to submitting, for record and possible publication, his conclusions regarding the availability of certain soils as a commercial source of nitrates.

The description of the fossil flora of the Laramie formation in the Denver Basin is in progress by F. H. Knowlton, and a monograph covering this work and including a historical account of the Laramie problem is now nearly completed.

In northern Colorado, from Windsor and Greeley southward to Boulder, full collections representing the fauna of the Fox Hills sandstone were made by T. E. Williard and T. W. Stanton, and a preliminary study for a comparison of them with the typical Fox Hills fauna has been made by Mr. Stanton. A collection of fossil plants from the Fox Hills sandstone has been described by F. H. Knowlton.

The Ordovician section at Canon City has been reviewed by Edwin Kirk for purposes of correlation.

The detailed examination of the mineral resources of the Yampa coal field was continued in the office by E. T. Hancock, who has submitted for publication economic reports on the Meeker, Axial, and Monument Butte quadrangles. Folios covering these quadrangles are also in preparation by Mr. Hancock. A general report on the entire Yampa coal field was submitted by Mr. Hancock for inclusion in the forthcoming paper describing the coal fields of the United States. The history of a portion of Yampa River and its possible bearing on that of Green River by Mr. Hancock was published as Professional Paper 90-K. In response to numerous requests received by the Survey, further investigations of four sections of

land in the Yampa coal field for the purpose of land classification, were made by Mr. Hancock.

The investigation of the oil shale in the Green River formation in northwestern Colorado and eastern Utah, which was begun by E. G. Woodruff prior to his resignation from the Survey in 1913, was continued in greater detail by D. E. Winchester, assisted by H. M. Robinson, who made a reconnaissance examination of about 1,000 square miles. In the course of this work the oil shale beds were examined at a number of places in western Colorado, many sections were measured in detail, and numerous samples, cut from different parts of the beds, were collected and subjected to distillation tests in the field. Many samples were also shipped to Washington, where distillation tests were made in the laboratory of the Bureau of Mines by Mr. Winchester under the direction of David T. Day. The field distillation experiments were observed for a short time by Dr. Day, who, together with C. A. Davis, D. E. Winchester, and David White, revisited the De Beque region, where oil shale of unusual interest was discovered by Mr. Woodruff the previous year. Field surveys were resumed by Mr. Winchester in June, 1915, with the intention of extending the examination northward into Wyoming. A report covering the investigations of the year was completed by Mr. Winchester and submitted for publication as a chapter in Bulletin 621. In the course of brief field studies of the deposition of the oil shale at a number of points, C. A. Davis, in company with David White, collected samples of the shale and began a paleontologic investigation of its origin and composition. The oil shale was found to be composed in large part of plant remains of low orders, mainly algæ and fungi. A collection of the oil shales of Colorado, Utah, and other States, arranged by Mr. Winchester, is now on exhibition at the Panama-Pacific Exposition.

The detailed investigation of the areal and economic geology and the classification of the lands in the Red Mesa and Soda Canyon quadrangles, begun by M. A. Pishel, who resigned from the Survey in August, 1914, was continued by A. J. Collier, assisted by O. B. Hopkins. Together they surveyed 238 square miles, in which geologic mapping was done and coal outcrops were located by plane-table methods. The land has been classified, and an economic report and a folio are in preparation by Mr. Collier, who is also preparing a popular geologic guide to the Mesa Verde National Park. Mr. Collier also examined in detail the northern part of the plateau north of the Red Mesa quadrangle, in T. 35 N., Rs. 12 and 13 W., comprising an area of about 16 square miles, for the purpose of classifying and valuing the land. An economic report on this area was prepared for publication.



In the Trinidad field, near Cokedale, examinations were made by M. W. Ball for the purpose of classifying and valuing the coal lands, the report to be prepared at a later date.

In the vicinity of Austin, in Delta County, an area of about 10 square miles, including a structural dome, was hastily examined by M. R. Campbell, for the purpose of determining whether or not the geologic conditions are favorable for the occurrence of oil or gas. The conclusions, which were unfavorable, were issued in the form of a press notice for the benefit of those interested in the region. Mr. Campbell also examined a half section of coal land in the vicinity of Mattison, Elbert County, to collect data for its classification and valuation.

A report on the coal resources of North Park, by A. L. Beekly, has been published as Bulletin 596.

#### CONNECTICUT.

The feldspar quarries in Middlesex County, Conn., in which mica and the gem minerals tourmaline, beryl, and lepidolite are found, and the old mica, feldspar, and beryl mine near New Milford, in Litchfield County, were examined by D. B. Sterrett.

#### DELAWARE.

The manuscript and maps describing the areal and economic geology of the Elkton and Wilmington quadrangles, in Pennsylvania and Delaware, have been submitted by Miss Florence Bascom and B. L. Miller, for publication as a folio. The small gas emissions coming from a number of shallow-water wells near the State boundary in the region of Salisbury, Md., were investigated by G. C. Matson. (See Maryland, p. 68.)

#### FLORIDA.

The stratigraphic and paleontologic investigations of the upper Eocene and Oligocene formations of Florida were continued by C. Wythe Cooke, who made a special study, for correlation, of the Ocala limestone and prepared a paper on the age of that formation.

At Laurel Hill and River Junction field conferences were held by T. Wayland Vaughan with Mr. Cooke and W. C. Mansfield, and data were gathered by Mr. Cooke on the structure of the Apalachicola group by running lines of levels in both areas. The Eocene and Oligocene formations at Marianna and Chipley and the Miocene at Redbay were restudied. Mr. Cooke also made a study of the upper Oligocene and Miocene formations on Apalachicola River between River Junction and Blountstown and on Chipola River. A report on the fossil mollusks of Chipola Oak Grove and Shoal River is in preparation by Miss Julia Gardner, and two reports on the Miocene

and Pliocene foraminifers of the Coastal Plain, including Florida, by Joseph A. Cushman, have been transmitted for publication.

Investigations of the Florida Keys region were continued by T. Wayland Vaughan, who prepared and published several scientific papers on the geology and recent deposits of this part of the coast.

A report on the phosphate deposits of Florida (Bulletin 604) by G. C. Matson, is in press and "A monograph of the molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Fla.," by William H. Dall, was published by the United States National Museum.

#### GEORGIA.

In continuance of the studies of the stratigraphy and paleontology of the upper Eocene and Oligocene formations in Georgia the Ocala and Chattahoochee formations at Bainbridge and vicinity were examined by C. Wythe Cooke, assisted by W. C. Mansfield. Instrumental level lines were run over the principal sections. The correlative results of the study are contained in the paper by Mr. Cooke on the age of the Ocala limestone already mentioned. A fauna at the base of the Chattahoochee formation, because of its wide geographic distribution in the Greater and Lesser Antilles, is being described by W. H. Dall.

A report of the fossil flora of the Claiborne group is in preparation by E. W. Berry.

The paper on "Underground water resources of the Coastal Plain of Georgia" (Water-Supply Paper 341), by L. W. Stephenson and J. O. Veatch, was published during the year.

Mica prospects in Hall and Cherokee counties were examined by D. B. Sterrett.

New openings on the red iron ore beds in Walker County were examined by E. F. Burchard.

#### IDAHO.

Studies which are to result in a comprehensive summary report on the ore deposits of Idaho, by J. B. Umpleby, were continued during the year. No field work was done, but a large amount of material previously collected was elaborated and prepared for publication. A report on the Mackay region, which embraces the drainage areas of Little and Big Lost rivers and Birch Creek, was transmitted by Mr. Umpleby for publication as a professional paper. He also finished a short paper on the ore deposits of the Sawtooth quadrangle (Bulletin 580-K) and has completed the description of the ore deposits in the Hailey quadrangle, the geology of which has been mapped for folio publication by L. G. Westgate, assisted by R. S. Knappen. Edwin Kirk, paleontologist, gave assistance in the solution of the stratigraphic problems of the area. In response to a



request from the Office of Indian Affairs, Mr. Umpleby examined and reported on leakages near the head of the Blackfoot Reservoir.

The gravels of the Fort Hall bottoms on Snake River were, at the request of the Office of Indian Affairs, investigated by J. M. Hill, who submitted a paper on gold in the Snake River gravels for publication (Bulletin 620-J).

The geologic mapping of the Wayan quadrangle, which includes the Crow Creek, Slug Creek, Lance Creek, and Freedom 15-minute quadrangles, was completed by G. R. Mansfield, assisted by E. L. Jones, jr., P. V. Roundy, and E. H. Finch. Progress has been made by Mr. Mansfield in the preparation of folios for the Wayan and Montpelier quadrangles, and a paper on the geology of the Fort Hall Reservation was prepared for unofficial publication by Mr. Mansfield, who, with E. S. Larsen, jr., is unofficially publishing a paper describing the occurrence of nepheline basalt in the Fort Hall Reservation. The Paleozoic and Triassic formations and faunas of the Wayan quadrangle were studied both in the field and in the office by G. H. Girty.

For the Henry district land-classification data were completed and transmitted, and a report on the economic geology of the district was begun by Mr. Mansfield, who has also submitted a manuscript on the geology and phosphate deposits of the Fort Hall Indian Reservation. A detailed examination for phosphate in part of the Crow Creek and Freedom quadrangles was made in order to classify the lands.

Reported deposits of nitrates in the vicinity of Homedale, Owyhee County, were examined by Mr. Mansfield, whose report "Nitrate deposits in southern Idaho," has been issued as Bulletin 620-B.

A report on a geologic reconnaissance in southeastern Idaho and western Wyoming, with special reference to phosphate deposits, was submitted by A. R. Schultz.

A report classifying the lands in the vicinity of Orofino Creek and Clearwater River, examined in 1913, was prepared by C. T. Lupton, who also submitted a manuscript for a paper on the Orofino coal field for publication (Bulletin 621-I).

A summary report on the coal fields of Idaho, based on work of previous years, was prepared by C. F. Bowen for publication in the paper dealing with the coal fields of the United States, which is being compiled under the direction of M. R. Campbell.

#### ILLINOIS.

Under the arrangement for cooperation with the Illinois Geological Survey, the areal geology and mineral resources of the Mount Olive and Gillespie quadrangles were mapped in detail by Wallace Lee, who prepared an economic report describing the coal resources, oil pros-

pects, and geologic structure for publication by the State geological survey, and who has brought a folio covering these quadrangles to an advanced stage. In the mapping of the glacial and associated deposits Mr. Lee conferred with W. C. Alden and E. W. Shaw. The investigation of the stratigraphy and the mapping of the areal geology in the Equality and Shawneetown quadrangles, also cooperative, was begun by Mr. Lee, and he examined portions of the Golconda and Fords Ferry quadrangles, on the Illinois side of Ohio River.

The glacial and associated deposits in the Edgington, Milan, Canton, Colchester, Macomb, Tallula, and Springfield quadrangles were briefly studied by W. C. Alden for comparison with similar deposits in Iowa.

The dark shale and bony coal overlying the Springfield (No. 5) coal bed were examined by G. H. Ashley for the purpose of collecting material to be subjected to distillation experiments.

The Pleistocene formations and physiography of the Baldwin, Chester, Renault, Kimmswick, and Crystal City quadrangles were further studied by E. W. Shaw with a view to their description in cooperative folios.

Folios for the Carlyle, Centralia, New Athens, and Okawville quadrangles were nearly completed by Mr. Shaw, the greater part of whose time was devoted to studies of Pleistocene deposits and sedimentation in the Gulf region of the Coastal Plain.

#### INDIANA.

A report on "The Pleistocene of Indiana and Michigan and the history of the Great Lakes," by Frank Leverett and F. B. Taylor, was published as Monograph 53.

In connection with the discussion and correlation of the formations in the vicinity of Cincinnati, Ohio, the Paleozoic formations and faunas in southeastern Indiana were studied by E. O. Ulrich.

Field examinations of the Devonian black shales in the New Albany region and of the dark shales and bony layers associated with some of the coal beds of the State were made by G. H. Ashley, who collected samples for laboratory distillation in order to determine their value as sources of petroleum distillates and their by-products.

#### IOWA.

A review of the evidence of an Iowan stage of glaciation and of its relations to the deposits of other Pleistocene stages in eastern Iowa and adjoining States occupied W. C. Alden during the greater part of the field season of 1914. This work was done in cooperation with the Iowa State Geological Survey, which furnished an assistant, Morris M. Leighton, for the season. The studies were resumed in June, 1915.

A short field conference on the mapping of the Quaternary deposits of northwestern Iowa was held between E. S. Carman, of the State Geological Survey, and Frank Leverett.

A short report containing a summary description of the coal fields and coals of Iowa was prepared by Henry Hinds for incorporation in the general report by M. R. Campbell on the coal fields of the United States.

The stratigraphy of the Mississippian formations in southeastern Iowa was examined and collections of fossils were made by F. M. Van Tuyl, of the State Geological Survey, the paleontologic supervision of the investigation being, through informal cooperation, in charge of Stuart Weller, who has conducted similar investigations for the Federal Survey in Missouri, Illinois, and western Kentucky.

#### KANSAS.

The description of the ore deposits of the Joplin district, Missouri, and of the Miami district, Oklahoma, with field studies extending into southeastern Kansas, was continued by C. E. Siebenthal, whose report on the origin of the zinc and lead deposits of the Joplin region (Bulletin 606) is now in press.

The Leavenworth-Smithville folio, by Henry Hinds and F. C. Greene, has been revised by Mr. Hinds.

#### KENTUCKY.

A detailed survey of the areal geology and mineral resources of Jefferson County, Ky., was completed by Charles Butts, assisted by T. C. Brown and J. J. Galloway. This survey was made in cooperation with the Kentucky Geological Survey, to which the report, now nearing completion, will be submitted for publication. Several quadrangles, including the Louisville and Kosmosdale, lie wholly or in part within Jefferson County, and it is planned that folios shall be prepared after certain problems have received further field consideration and after small areas lying outside of the county have been mapped.

Field studies in the stratigraphy and paleontology of the early Paleozoic formations of central Kentucky and in the Louisville quadrangle were made by E. O. Ulrich.

Several Carboniferous sections in southeastern Kentucky were examined for purposes of correlation by G. H. Girty.

The phosphate deposits in Woodford and adjoining counties have been examined partly in reconnaissance and partly in detail by W. C. Phalen, who explored portions of this relatively little known phosphate field by means of shallow drilling. A large number of samples were collected for chemical analysis. The results of these investigations are designed to be incorporated in a report on the phosphate deposits of the southern Appalachian region.

A study of the physiography and the Quaternary geology of the western part of the State, by E. W. Shaw, is in progress as a part of an investigation covering the late Pleistocene geologic history of the Mississippi embayment.

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, including areas in Kentucky, is in press.

## LOUISIANA.

With the object of guiding exploration in the discovery and the development of oil pools in Louisiana, preliminary reconnaissance examinations of the geologic structure with special reference to the presence of oil and gas were made by G. C. Matson, assisted by O. B. Hopkins and E. H. Finch, in a number of districts, most attention, however, being given to Bossier, De Soto, Caddo, and Red River parishes. Reports covering this work are now in preparation. At the request of the General Land Office an examination of the islands in Sabine River near Orange, Tex., was made by Mr. Hopkins for the purpose of land classification.

A report on the iron-bearing deposits in Bossier, Caddo, and Webster parishes, by E. F. Burchard, the field work for which was done in the fall of 1914, is ready for publication as Bulletin 620-G.

The upper Tertiary formations in southwestern Louisiana were examined by G. C. Matson and Alexander Deussen, and fossil plants and invertebrates from several localities and formations have been studied by E. W. Berry and C. Wythe Cooke. Reports now in preparation include a study of the floras of the Claiborne and Jackson groups by Mr. Berry and a general report on the physiography and surficial geology of the Gulf embayment by E. W. Shaw. A manuscript by Mr. Matson on the Pliocene of the eastern and central Gulf Coastal Plain and two manuscripts on the Catahoula formation, the stratigraphy being described by Mr. Matson and the fossil plants by Mr. Berry, were transmitted for publication.

Supplementary investigations of the stratigraphy, paleontology, and ground waters of the Cretaceous deposits of northeastern Louisiana were made by L. W. Stephenson.

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, is in press, and Bulletin 619, "The Caddo oil and gas field, Louisiana," by G. C. Matson, is in the hands of the editor.

## MAINE.

Additional field examinations were made by Frank J. Katz in the Portland and Casco Bay quadrangles for the solution of problems which arose during the office preparation of a folio for these quadrangles. This review, during which Mr. Katz was joined by Arthur Keith for field conference and inspection, was not made in cooperation

with the State, though the greater part of the previous work on these quadrangles was done in cooperation. The text and maps for this folio are nearing completion.

The areal survey of the Dover and York quadrangles was commenced by Mr. Katz, who has covered about 50 square miles, and progress was made on the maps and collections in the office.

In the Boothbay quadrangle a brief reconnaissance covering about 20 square miles was made by Mr. Keith.

Professional Paper 89, "The fauna of the Chapman sandstone," by H. S. Williams, has been revised by the author and a chapter on the Ostracoda of the formation has been added by E. O. Ulrich. This paper is now in press.

#### MARYLAND.

The mapping of the Williamsport quadrangle, which includes portions of West Virginia and Pennsylvania, was completed by George W. Stose, who covered about 100 square miles in detail. The descriptions and maps for this quadrangle, which with the Hagerstown quadrangle will be covered by a single folio, are well advanced toward completion. This folio was provided for under cooperation with the Maryland Geological Survey. Conferences for deciding certain questions of stratigraphy and correlation were held by Mr. Stose, E. O. Ulrich, and R. S. Bassler in the Hagerstown and Frederick quadrangles.

The folio for the Elkton and Wilmington quadrangles, including parts of Pennsylvania and Delaware, was transmitted for publication. This folio was prepared by Miss Florence Bascom and B. L. Miller, in cooperation with the Geological Survey of Maryland.

The Tolchester folio, by B. L. Miller, E. B. Mathews, Arthur B. Bibbins, and Homer P. Little, also cooperative, was completed and transmitted for publication.

At the request of the Committee on Public Buildings of the House of Representatives a marble quarry near Union Bridge, Carroll County, was examined by T. N. Dale, in association with Oliver Bowles, quarry technologist of the Bureau of Mines. A short report on the rocks examined was transmitted to the committee.

In order to ascertain whether the small emissions of gas proceeding from a number of shallow wells driven for water in the region of Salisbury, Md., were of deep-seated (rock) origin, and if so whether they might be regarded as indications of possible gas or oil pools in the region, an examination was made by G. C. Matson. The results of this investigation were not sufficiently encouraging to merit formal publication.

For the more accurate differentiation and discrimination of the Pleistocene formations of the Maryland portion of the Coastal Plain

an inspection of the terraces of peninsular Maryland was made by T. Wayland Vaughan, E. W. Berry, and P. S. Smith, in conference with W. B. Clark, director of the State Geological Survey.

## MASSACHUSETTS.

Reviews necessary to the completion of the descriptions of the Boston and Boston Bay quadrangles were made by Laurence La Forge. The preparation of the Boston folio, which is to cover these quadrangles, is now well advanced. Reconnaissance examinations were made by Mr. La Forge in the Haverhill, Lowell, Lawrence, Newburyport, and Salem quadrangles. A field conference was held in the Framingham quadrangle by Mr. La Forge and Arthur Keith, who inspected the geologic mapping.

The areal and economic survey of the Greylock quadrangle was continued by L. M. Prindle, who conferred with Mr. Keith in the field.

The Sheffield-Sandisfield folio was the subject of an office conference between Arthur Keith, Joseph Barrell, and B. K. Emerson. Mr. Keith also conferred with Mr. Emerson regarding the Pittsfield and Becket geologic work and certain features of Mr. Emerson's report on the geology of Massachusetts (Bulletin 597).

Manuscript maps and geologic descriptions for the Worcester-Marlboro, Palmer-Brookfield, Webster-Blackstone, and Belchertown-Barre folios have been submitted by Mr. Emerson, and his office work on the Warwick-Winchendon folio has been continued to an advanced stage.

Field studies of the geology of Cape Cod, Nantucket, Marthas Vineyard, and the Elizabeth Islands were begun in June by J. B. Woodworth, with the object of mapping and preparing a report on the geology of this portion of the Atlantic Coastal Plain.

The field examination of the Quaternary geology of the Berlin and Greylock quadrangles, in New York and Massachusetts, was completed by F. B. Taylor, who has prepared a manuscript describing the surficial deposits for folio publication.

Deposits containing tourmaline, beryl, and lithia minerals in the vicinity of West Chesterfield and Goshen, Hampshire County, were examined by D. B. Sterrett.

## MICHIGAN.

The report on "The Pleistocene of Indiana and Michigan and the history of the Great Lakes," by Frank Leverett and F. B. Taylor, has been published as Monograph 53, and a special report on the extent and relations of the Superior ice lobe in Michigan, Wisconsin, and Minnesota is in preparation by Mr. Leverett.



In accordance with an informal arrangement for cooperation with the Michigan Geological Survey in paleontologic investigations, the Marshall fauna of the State has been studied by G. H. Girty.

#### MINNESOTA.

The work of mapping the glacial deposits of Minnesota, with special reference to the origin of the soils, was continued by Frank Leverett, assisted by F. W. Sardeson, of the State Geological Survey. A report entitled "Surface formations and agricultural conditions of northwestern Minnesota," by Frank Leverett, with a chapter on the climatic conditions of Minnesota, by U. G. Pursell, was transmitted to the State and published as Bulletin 12 of the Minnesota Geological Survey. This is the first of a series of papers to be based on this work. Manuscript for a report on the soils and surface deposits of northeastern Minnesota has been prepared by Mr. Leverett for publication by the State, and he has done considerable work, with the assistance of Mr. Sardeson, on a general report on the Quaternary deposits and history of Minnesota, to be published by the Federal Survey.

A brief reconnaissance study of the pre-Wisconsin Quaternary deposits in some of the southeastern counties of the State was made by W. C. Alden, for comparison with similar deposits in Iowa. Field conferences regarding the mapping and classification of these deposits were held between Messrs. Leverett, Sardeson, and Alden and between T. C. Chamberlin and Mr. Leverett.

Cooperative studies preliminary to a general report on the stratigraphy and economic geology of the Cuyuna iron range were made by E. C. Harder, of this Survey, and A. W. Johnstown, of the State Survey. A preliminary paper on the bacterial deposition of iron ores has been prepared by Mr. Harder for publication in "Shorter contributions to general geology." Under cooperative agreement also studies of the magnetite ores of the State were begun by F. F. Grout, of the Minnesota Survey, and H. H. Brodt.

As products of previous cooperative work conducted with the State Geological Survey a report on the clays and shales of Minnesota, by F. F. Grout, and a similar report on the building stones of the State, by Oliver C. Bowles, were completed and submitted for publication in bulletin form.

#### MISSISSIPPI.

Structural studies for the purpose of finding geologic conditions favorable to the occurrence of oil or gas in the Vicksburg quadrangle, Miss., were carried on by G. C. Matson, O. B. Hopkins, and E. H. Finch. A report containing the results of this investigation is now in preparation. Brief examinations were also made by Mr. Matson at Hattiesburg, Natchez, and Seminary.



Reports on the geology of the Coastal Plain of Mississippi and on the ground waters of the State are in preparation. The investigations have been carried on in cooperation with the State Geological Survey of Mississippi, field work being done by five geologists of the Federal Survey and E. N. Lowe, State geologist.

The examinations of the upper Eocene and Oligocene formations in the State were continued by C. Wythe Cooke, who has transmitted a paper entitled "The age of the Ocala limestone" (Professional Paper 95-I). This report will be of special value for correlation.

A report on the physiography, surficial deposits, and Pleistocene geologic history of the Gulf embayment, which is in preparation by Mr. Shaw, will embrace the State of Mississippi. In connection with this investigation Mr. Shaw is making a special study of the silts of the Mississippi Valley.

Additional field studies of the post-Eocene geologic formations were made by G. C. Matson, who cooperated with Mr. Shaw in a part of the investigations of the latest Tertiary and Pleistocene formations.

A report on the fossil flora of the Claiborne group, which is exposed in Mississippi, is in preparation by E. W. Berry. Reports covering the results of earlier field and office investigations submitted during the year include a manuscript on the Pliocene of the eastern and central Gulf Coastal Plain by G. C. Matson; two manuscripts on the Catahoula formation, one on the stratigraphy by Mr. Matson and one on the fossil plants by Mr. Berry; and a manuscript entitled "Erosion intervals in the Eocene of the Mississippi embayment," by Mr. Berry (Professional Paper 95-F).

Professional Paper 91, "The lower Eocene floras of southeastern North America," by E. W. Berry, is now in press.

#### MISSOURI.

A report by C. E. Siebenthal on the origin of the Joplin lead and zinc ores, now in press as Bulletin 606, contains conclusions based on a long and thorough investigation of the geology and ore deposits of the Joplin region.

In response to a request of the State geologist the earlier Paleozoic formations of eastern and central Missouri were briefly studied for purposes of classification and correlation by E. O. Ulrich. On the part of the State additional investigations, both paleontologic and stratigraphic, of the Mississippian formations, mainly in Ste. Genevieve County, were made by Stuart Weller.

Further field examinations of the Pleistocene deposits in the Crystal City and Renault quadrangles, for which geologic folios are in preparation in cooperation with the Missouri Bureau of Geology and Mines, were made by E. W. Shaw.

The Green City-Queen City folio text, by F. C. Greene, was critically revised by Henry Hinds, under whose supervision the field and office work relating to these quadrangles was done. Some revisory work was also done by Mr. Hinds on the Leavenworth-Smithville folio, the geologic maps for which are now engraved.

A chapter describing in summary form the coal fields of Missouri was prepared by Mr. Hinds for inclusion in the work by M. R. Campbell on the coal fields of the United States.

#### MONTANA.

A portion of the Judith River coal field in northeastern Chouteau and Fergus counties, Mont., embracing about 600 square miles, was geologically surveyed in a detailed reconnaissance examination by E. R. Lloyd, assisted by W. T. Thom, jr., and W. B. Wilson. The lands of this area have been classified and an economic report has been prepared, but the publication of this report will be delayed to incorporate the results of additional field work. A paleontologic study of the Cretaceous and Eocene formations of this region was made by T. W. Stanton for purposes of correlation.

A report on the subbituminous coal and lignite regions of eastern Montana is in preparation by E. R. Lloyd for publication in the forthcoming paper on the coal fields of the United States. The completion of Mr. Lloyd's manuscript is somewhat retarded on account of his recent transfer from the geologic branch to the land-classification board, where he was made secretary of the coal board.

The geology and coal resources of northern Teton County will be described by Eugene Stebinger in Bulletin 621-K.

An area of about 1,300 square miles in the Porcupine dome, north of Forsyth, was examined in a reconnaissance way, for the purpose of land classification, by C. F. Bowen, assisted by C. A. Bonine. The possibilities of oil in the Porcupine dome have been described by Mr. Bowen in Bulletin 621-F. Mr. Bowen also submitted a report on the stratigraphy of the Montana group, with special reference to the stratigraphic position and age of the Judith River formation, which has been published as Professional Paper 90-I.

A description, with maps, of the Tullock Creek coal field, which was examined in 1912-13, was completed and submitted for publication by G. S. Rogers, and a report on the Bull Mountain coal field, by R. W. Richards and C. T. Lupton, has been submitted.

A small area of lignite land near Glendive was examined for the purpose of classification by C. E. Leshner.

The areal mapping of the coal fields of southeastern Montana, which was begun in 1913, was continued by C. M. Bauer, with the assistance of E. M. Parks and R. W. Brown. This work was done primarily for purposes of land classification, but the areal geology

was also studied and mapped. Mr. Bauer examined about 800 square miles in more or less detail, and 1,500 square miles, mainly outside of the coal field, in a rapid reconnaissance. An economic report on the Ekalaka and Long Pine Hills coal field of southeastern Montana, studied in 1913-14, is now in preparation by Mr. Bauer.

An examination of the northeast corner of this State, north of the Fort Peck Indian Reservation, was begun by A. J. Collier, assisted by W. T. Thom, jr., for the purpose of classifying the land. An investigation of the Milk River valley was undertaken by Eugene Stebinger, assisted by W. P. Woodring and J. D. Sears.

The paleontology and stratigraphy of the formations on the north side of Yellowstone River, west and north of Forsyth, were studied by T. W. Stanton, who, in cooperation with C. W. Gilmore and the field party in charge of E. R. Lloyd, also made a careful review of the type area of the Judith River formation on the Missouri near the mouth of the Judith.

The placer deposits at Ruby and Virginia City were visited by J. M. Hill in connection with his general investigation, cooperative with the Bureau of Mines, of the placer deposits of the United States.

In the Browning and Chief Mountain quadrangles, in the Glacier National Park, areal geologic mapping was continued by Eugene Stebinger, with the assistance of C. S. Corbett and H. R. Bennett, about 725 square miles being mapped in detail on the 1:125,000 scale. Progress in the preparation of a report for the area has been made by Mr. Stebinger, who also prepared text, maps, and illustrations for the Blackfoot-Cutbank folio, the areal mapping of which was completed during the previous field season.

Final revision of the text of the Philipsburg folio was completed by F. C. Calkins.

#### NEVADA.

In the search for potash, under the supervision of H. S. Gale, boring was continued to a depth of 1,500 feet in the Black Rock Desert, Nev., when the coming of winter terminated the work. The drill crew was superintended by D. H. Walker, to whose skill and efficiency are due the economy and speed of the work and the completeness of the data gathered. Samples of the drillings were collected by M. I. Goldman and A. T. Crandall, and these are now undergoing analytical study by Mr. Goldman. Through the courtesy of the Department of Agriculture the diatoms have been examined by Dr. Albert Mann, specialist in the Diatomaceæ. A number of reported discoveries of potash salts or nitrates within the State were investigated by Mr. Gale, and analyses of submitted samples of salts were made in the chemical laboratory. No bed of potash salts was discovered in the deep well. The reported deposits proved on examination to

be either too low in potash or nitrates or too small to be of commercial importance.

In the spring of 1915 a new drilling equipment designed especially for the work and region was purchased, and surveys were made in the Smoke Creek Desert by Mr. Gale to determine localities that would appear relatively favorable for testing. Preparations were completed by Mr. Walker to resume drilling in that desert with the new rig early in July.

Nitrate-bearing beds north and northwest of the Black Rock Desert were examined by M. I. Goldman.

The Yerington district was studied in detail by Adolph Knopf and E. L. Jones, jr., who mapped 58 square miles on the scale of 1 : 24,000. The results of this survey are now being prepared for publication. The cinnabar deposits east of Beatty and Mina were examined by Mr. Knopf, the results of whose investigations have been submitted for publication under the title, "Some cinnabar deposits in western Nevada" (Bulletin 620-D). The platinum deposits in the Yellow Pine district, Clark County, were investigated by Mr. Knopf, whose report, "A gold-platinum-palladium lode in southern Nevada," has appeared as Bulletin 620-A. A paper entitled, "Plumbojarosite and other basic lead-ferric sulphates from the Yellow Pine district, Nevada," was prepared by Mr. Knopf for unofficial publication.

The Rochester mining district is described by F. C. Schrader in Bulletin 580-M, issued during the year, and a report on "Some mining districts in northeastern California and northwestern Nevada" (Bulletin 594), by J. M. Hill, was also published.

A reconnaissance report on some mining districts in eastern Nevada, mostly in Elko, White Pine, Lincoln, and Clark counties, and on the Ravenswood district, in Lander County, has been submitted for publication by Mr. Hill.

The economic geology of the National district is described by Waldemar Lindgren in Bulletin 601, recently issued; and a detailed report on the geology and ore deposits of the Ely district, by A. C. Spencer, is in the editor's hands. In the preparation of the Ely report Sidney Paige collaborated in the office with Mr. Spencer.

The oxidized zinc ores near Eureka were investigated by G. F. Loughlin, the mining districts of the Carson Sink quadrangle are being described by F. C. Schrader, and an examination of the geology and ore deposits of the Manhattan district was begun by H. G. Ferguson.

A short paper on the occurrence of wurtzite at Goldfield was unofficially published by F. L. Ransome.

The silver ores of the Tonopah district are under investigation by metallographic methods, with reference to their association and origin, by E. S. Bastin, in collaboration with F. B. Laney.

## NEW HAMPSHIRE.

Mica deposits, locally with gem beryl as an associated mineral, were examined in eleven townships in Grafton, Cheshire, and Stratford counties, N. H., by D. B. Sterrett, who nearly completed the field investigation of the principal deposits, preliminary to a description of the occurrence of mica in New Hampshire. The gem deposits will be described in a report on the occurrence of precious stones in the United States now in preparation.

The areal survey of the Dover and York quadrangles, including portions of Maine, was begun by F. J. Katz, who has also begun the office compilation of the field data.

The examination of the Peterboro quadrangle was continued during a portion of the field season by B. K. Emerson, who for a time was joined in a field reconnaissance by Arthur Keith. A brief reconnaissance was made in the Keene quadrangle by Mr. Keith. Portions of the Lowell, Lawrence, and Newburyport quadrangles, lying partly in Massachusetts, were examined by Laurence La Forge.

## NEW JERSEY.

The areal survey of the Easton quadrangle, in New Jersey and Pennsylvania, was completed by H. B. Kümmel, the work being carried on in cooperation with the New Jersey Geological Survey. The manuscript and maps for this quadrangle will form part of the Allentown-Easton folio and are well advanced toward completion.

In accordance with the plan of the Survey to print on the backs of topographic maps that cover large centers of population or points of unusual scenic interest popular and instructive descriptions of the geography and of the origin of the physical features, a description of this sort was prepared by G. W. Stose for the Delaware Water Gap sheet. This description is based on field work done in the quadrangle, which lies largely in Pennsylvania, by W. S. Bayley and H. B. Kümmel, and on Mr. Stose's personal knowledge of the region. The general geologic data now available as to the quadrangle will probably be amplified when the study of the adjoining Wind Gap quadrangle has been made in order that both quadrangles may be covered in a single folio.

## NEW MEXICO.

In connection with the general search for deposits of potash and nitrate salts, the investigation of the depositional basins in the "Red Beds" region of New Mexico was continued by N. H. Darton, whose principal object was to discover the centers of greatest evaporation of saline waters in the past.

The chief study of metalliferous areas undertaken in New Mexico during the year was that of the copper deposits at Santa Rita (Chino district), to which A. C. Spencer was assigned. With Mr. Spencer



were associated Sidney Paige, who studied the structure and superposed the geology on the Santa Rita special map; D. F. MacDonald, who examined the mining methods, especially the open-pit mining; and J. F. Hunter, jr., who assisted in the areal geologic mapping. Toward the close of the field season the district was visited by F. L. Ransome for the discussion of problems with Mr. Spencer.

The studies of mining methods by Mr. MacDonald were carried on in connection with the general investigation of the application of geologic features to the problems of mining and engineering construction, prosecuted in cooperation with the Bureau of Mines.

A study of the zinc ores of the Magdalena district was begun by G. F. Loughlin.

The geology and water resources of Luna County are described by N. H. Darton in Water-Supply Paper 345-C, recently issued.

A study of the geology and coal resources of the Raton and Brilliant quadrangles, in the Raton coal field, Colfax County, was completed by W. T. Lee, and an economic report covering the area has been submitted for publication. A folio by Mr. Lee describing in detail the geology of the quadrangles is in preparation.

The Datil Mountain region was revisited by D. E. Winchester for the purpose of collecting additional information regarding the stratigraphy and correlation of certain coal beds. Field work is now completed in the Datil Mountain region and in the Zuni Indian Reservation, and an economic report on these areas is in preparation by Mr. Winchester.

At the request of the Office of Indian Affairs, lands coming under the Hogback canal in the Navajo Indian Reservation were examined in 1913 by M. A. Pishel. A report on the area was submitted by Mr. Pishel prior to his resignation from the Survey to accept a more remunerative position in one of the large oil companies operating in the Southwest.

A detailed examination, for the General Land Office, of lands near Gallup, McKinley County, was made by C. T. Lupton, who is now preparing a geologic report on the area.

An extended and elaborate study of the San Juan coal basin, in the northwest corner of the State, was begun by C. M. Bauer, assisted by J. B. Reeside, jr., the purpose being to obtain data for classifying the lands in the interior of this great basin and for determining the age and the correlation of the formations. The results of this investigation will be available for use in preparing the Red Mesa and Soda Canyon folios.

NEW YORK.

The mapping of the Quaternary deposits of the Berlin (N. Y.—Mass.) and Hoosick (N. Y.—Vt.) quadrangles was completed in July, and descriptions for folio publication have been nearly completed by

F. B. Taylor. The areal and economic survey of the Paleozoic formations in the Berlin quadrangle, which includes a small portion of Massachusetts, was continued by L. M. Prindle, about 125 miles having been mapped in detail.

The examination and mapping of the Paleozoic formations in the Hoosick quadrangle was completed by Mr. Prindle, who will describe this quadrangle in a folio covering also the Bennington quadrangle.

The study of the Quaternary deposits of the Cambridge and Fort Ann quadrangles was begun by Mr. Taylor.

#### NORTH CAROLINA.

Manuscripts and maps for a folio describing the Kings Mountain and Gaffney quadrangles, the larger part of which lie in South Carolina, has been nearly completed by D. B. Sterrett.

The Lincolnton quadrangle has been mapped by Mr. Sterrett, who has prepared descriptions for inclusion in a folio to cover also the Gastonia quadrangle, in which field work will be begun this summer.

Some mica deposits in Avery, Mitchell, and Macon counties and the results of the latest prospect work done in 1914 at the Ruby mine, in Cowee Valley, were examined by Mr. Sterrett, who visited several mica manufacturing plants to study the conditions of the industry.

In connection with a report on the marbles of the southeastern United States, which is being prepared in cooperation with the Bureau of Mines, the Bureau of Standards, and the Office of Public Roads, T. Nelson Dale devoted a short time to field investigations in this State.

The preparation of a cooperative monograph on the worms and mollusks of the Upper Cretaceous deposits of the Carolinas, by L. W. Stephenson, to be published by the North Carolina Geological and Economic Survey, has been nearly completed and the report will soon be transmitted. The Cretaceous Crustacea from the State have been described by Miss Mary T. Rathbun, of the United States National Museum, in a report to accompany Mr. Stephenson's paper, and the fossil plants have been described for the same purpose by E. W. Berry.

A monograph describing the Tertiary Mollusca of Virginia and North Carolina, for which Dr. Paul Bartsch, of the National Museum, described several families of the smaller Mollusca, has been completed by Miss Julia Gardner. The services of all those who are engaged on this work, except Mr. Stephenson, were contributed in scientific cooperation, without expense to the Survey.

A monograph on the Pliocene and Pleistocene Foraminifera of the Atlantic and Gulf Coastal Plain, in which the Foraminifera from North Carolina are included, has been transmitted for publication by J. A. Cushman.



## NORTH DAKOTA.

A detailed reconnaissance survey, covering about 590 square miles in the Oliver County lignite field, North Dakota, was made by E. T. Hancock, with the assistance of R. C. Moore. The results of this examination, which was made primarily for land classification and to solve certain problems relating to the stratigraphy of the region, have been embodied in a geologic report by Mr. Hancock, now nearly completed. In connection with the field investigations, studies relating to the stratigraphy of the Cannonball marine member of the Lance formation and to the stratigraphy and faunas of the Cretaceous and Eocene formations in surrounding regions were made by T. W. Stanton, who examined exposures north and south of Steel, near Jamestown, between Linton and Missouri River, and along Cannonball and Wisconsin rivers from Solen to Washburn.

The Fort Berthold lignite field is described and mapped in a final report submitted by C. M. Bauer, who has also prepared a short summary report on the lignite resources of North Dakota for inclusion in the general report on the coal fields of the United States.

The geology of the Edgeley and Lamoure quadrangles has been examined for folio publication by H. A. Hard under a cooperative agreement with the State Geological Survey of North Dakota.

## OHIO.

A folio for the Hamilton and Mason quadrangles, which were mapped in detail by R. S. Bassler and N. M. Fenneman, as previously reported, is nearly finished, its completion awaiting only the results of additional investigations, largely paleontologic, to be made by E. O. Ulrich in the Cincinnati quadrangle. Some general review work was done by Mr. Ulrich in the quadrangle.

The areal and economic geology of the Woodsfield and Summerfield quadrangles was examined in detail by D. Dale Condit, assisted by R. V. A. Mills and for a short time by C. A. Bonine. Careful attention was given to the structure of the oil sands and the relations of the oil pools to the geologic structure and to the character of the sands themselves. Two economic reports on the structure and oil resources of these quadrangles are now nearly completed and a folio is in preparation.

Some progress has been made in the preparation of a folio text covering the Steubenville and Cadiz quadrangles, on which Mr. Condit had been previously engaged; but this work was interrupted by his detail to examine and classify supposed phosphate-bearing lands in western Wyoming.

A preliminary examination of the Wooster oil and gas field was made by C. A. Bonine, and a report on the geologic structure, the

mode of occurrence of oil and gas, and the prospects of the field has been submitted by Mr. Bonine for publication (Bulletin 621-H).

The field investigation and mapping of the Wellsville quadrangle were carried on by J. H. Hance, special attention being given to the clay deposits and the clay-bearing formations.

The richly carbonaceous Devonian shales were examined and sampled at a number of points by G. H. Ashley, with a view to determining their value for distillation.

#### OKLAHOMA.

In order to procure further data as to the structure of the oil sands in the Hominy quadrangle, Oklahoma, some additional reconnaissance work was done by Robert H. Wood, whose oil report for the quadrangle is nearing completion and whose folio is well advanced. Considerable progress was made by Mr. Wood on the economic report covering the Cleveland pool.

The Pawhuska quadrangle was revisited by C. D. Smith for the purpose of verifying certain conclusions he reached during the office study of his notes, and considerable progress has been made on the folio covering the quadrangle. The folio for the Claremore quadrangle, which also was visited for slight revision, was nearly completed when, at the end of January, Mr. Smith resigned from the Survey in order to make a more lucrative use, as consulting oil geologist, of his practical knowledge and experience in oil-field geology. However, Mr. Smith has agreed to complete the folio.

Considerable progress has been made by Mr. Smith in the preparation of a folio covering the Sallisaw and Sanbois quadrangles, the geologic mapping of which was begun some years ago by J. A. Taff, a former member of the Survey now in the employ of the Southern Pacific Co. The completion of this folio, which had been delayed pending the receipt of additional data from Mr. Taff, is now subject to further postponement on account of Mr. Smith's resignation.

The areal and economic survey of the McAlester quadrangle was completed a number of years ago by Mr. Taff, who is under agreement to complete a folio for this area.

The Paleozoic geology and the Quaternary deposits in the northern half of the Windingstair quadrangle and the eastern part of the Tuskahoma quadrangle was briefly reviewed by H. D. Miser. The areal work in these quadrangles was begun a number of years ago by Mr. Taff.

The Loco, Duncan, and Lawton districts were examined by C. H. Wegemann, assisted by R. W. Howell and K. C. Heald, with the object of discovering the relation of the oil pools to the geologic structure and of obtaining information for guidance in the extension of known pools and the possible discovery of new ones. Preliminary

accounts, with sketch maps covering the areas, were transmitted to the Oklahoma Geological Survey, by which they have since been published.

Work on the Healdton pool, which was begun last year, was continued by Mr. Wegemann, assisted by Mr. Heald, and a report thereon is in press as Bulletin 621-B. Reports on the Loco and Duncan (Hope) gas fields and on the Lawton gas and oil pool, by Mr. Wegemann and R. W. Howell, are in press as Bulletins 621-C, 621-D, and 621-G, respectively.

Structural examinations, with reference to the possible occurrence of oil and gas, were made in portions of Okmulgee and Okfuskee counties by A. E. Fath, assisted during part of the field season by W. B. Emery and K. C. Heald. A report on "Faulted structure in the vicinity of the recent oil and gas development near Paden, Okfuskee County, Okla.," has been submitted by Mr. Fath. He also prepared a paper for unofficial publication on the segregation of copper ores in the "Red Beds."

The economic and areal survey of the geology of the Foraker quadrangle was begun by Mr. Heald and a similar investigation of the Bristow quadrangle by Mr. Fath.

Additional examinations of the lead and zinc deposits of the Miami district were made near the close of the year by C. E. Siebenthal. The data will be used in a report on these deposits which is now in preparation by him.

"The fauna of the Wewoka formation of Oklahoma," by G. H. Girty, was published as Bulletin 544.

#### OREGON.

In the Sumpter quadrangle, Oregon, about half of which had previously been examined, the remaining part was geologically surveyed in detail on the scale of 1 : 125,000, for folio publication, by J. T. Pardee and D. F. Hewett under a cooperative agreement with the Oregon Bureau of Mines and Geology, to which a preliminary report on the mineral resources of the quadrangle was submitted for publication. In June Mr. Hewett made some reconnaissance examinations in the region immediately west of the quadrangle. A geologic folio for Sumpter quadrangle is now in preparation for publication by the Federal Survey.

A reconnaissance examination of the Howard mining district was made in August by G. F. Loughlin.

Nitrate prospects in Malheur County, not far from Homedale, Idaho, were visited by G. R. Mansfield, whose report was submitted for publication (Bulletin 620-B).

The investigation of the Eden Ridge coal field was completed by C. E. Leshner, who examined in detail 36 square miles and in recon-

naissance 200 square miles, covering parts of Eden Ridge and Camas Valley. The stratigraphic position of the scattered coal outcrops was determined by Mr. Leshner, thus defining the productive formation. A portable outfit devised for the field determination of the amount of ash in coals is described by Mr. Leshner in Bulletin 621-A.

## PENNSYLVANIA.

The region between the Bellefonte and Huntingdon quadrangles, Pennsylvania, which have already been under examination, was reviewed in reconnaissance by Charles Butts, for the purpose of tracing certain formations between the two quadrangles and determining their stratigraphic relations. The folio for the Huntingdon and Hollidaysburg quadrangles is near completion, lacking only a review of certain details. A conference will be held by Mr. Butts and E. S. Moore, geologist engaged in the study of the Bellefonte quadrangle, before the folio for that quadrangle can be completed for publication. In connection with the description by C. D. Walcott, secretary of the Smithsonian Institution, of the Cambrian paleontology and stratigraphy of the United States, Mr. Butts spent some time in working out the Cambrian-Ordovician relations in the Hollidaysburg quadrangle.

A description of the physical features in the Delaware Water Gap quadrangle and the geography of the region was prepared by G. W. Stose. (See New Jersey, p. 75.)

Field work on the Fairfield and Gettysburg quadrangles having been completed, the manuscript and maps for a folio are in preparation by Miss Florence Bascom and G. W. Stose. A petrographic report on the Triassic lavas, for incorporation in this folio, was prepared by J. Volney Lewis.

The folio covering the Elkton and Wilmington quadrangles, by Miss Bascom and B. L. Miller, has been transmitted for publication. (See Maryland, p. 68.)

The geology of the Allentown quadrangle has been the subject of a field conference between Arthur Keith, in charge of the work, and B. L. Miller and H. B. Kümmel, geologists responsible for the mapping of the Allentown and Easton quadrangles, respectively. Mr. Miller has completed the maps and text for the Allentown quadrangle, and Mr. Kümmel is preparing similar material for the Easton quadrangle, the greater portion of which lies in New Jersey. The two quadrangles will be covered by a single folio. A report on the geology and economic resources of the Allentown quadrangle has been submitted by B. L. Miller.

Additional field work, mainly in adjustment of geologic boundaries to a new topographic base for the Reading quadrangle, has been

completed in the Reading and Boyertown quadrangles by Miss Bascom and Edgar T. Wherry, assistant. Mr. Wherry also examined recently operated quarries and mines in both quadrangles in order to complete his description of the economic geology and developments in the area. The pre-Cambrian rocks in the Reading quadrangle were mapped by Miss E. F. Bliss. Miss Bascom's work of preparing the folio is now well advanced.

The survey of the areal geology of the McCalls Ferry and Quarryville quadrangles, begun by E. B. Mathews, was continued by Miss Bliss. The results are to be published in folio form.

Field investigations were carried on by Mr. Wherry and Miss Bliss in the Quakertown and Doylestown quadrangles, the Paleozoic rocks being partly mapped by Miss Bliss and the Triassic rocks by Mr. Wherry. A portion of the folio for these two quadrangles is to be prepared by Miss Bascom and is well advanced toward completion.

Considerable progress has been made by Miss Bascom on the manuscript and maps for the Coatesville and West Chester quadrangles, which will be covered by a single folio, and on the Honeybrook-Phoenixville folio, which she expects to complete during the coming year.

Several local investigations regarding artesian-water conditions in eastern Pennsylvania have been made by Miss Bascom.

Satisfactory progress has been made in the investigation and mapping of the geology of the Frostburg and Flintstone quadrangles, which are to be covered by a single folio. The field and office work by Mr. Stose for his part of the folio has been finished for some time, and the completion of the folio manuscript awaits the descriptions to be furnished by C. K. Swartz for the Devonian and Carboniferous formations. The work is being done in cooperation with the Maryland Geological Survey.

The preparation of maps and descriptions of the geology and mineral resources of the Punxsutawney, Curwensville, and Houtzdale quadrangles has been continued by G. H. Ashley whenever his other duties gave opportunity.

The deposits of cannel coal and the richly carbonaceous shale mined or exposed at several points in western Pennsylvania were examined by Mr. Ashley, who collected a number of samples for tests in order to determine their ultimate value as possible sources of gas or petroleum distillates and distillation by-products.

Some progress has been made in the preparation of the Newcastle folio, although the demands made upon F. W. De Wolf, the author, by his duties as State geologist of Illinois are so overwhelming that little time is available for the Pennsylvania work.

The geology of the Windber quadrangle has been investigated in detail by George B. Richardson, who has submitted a folio to cover

the Windber and Somerset quadrangles, the latter having been examined during the preceding season. An economic report entitled "Geologic structure and coal resources of the Windber and Somerset quadrangles, Pennsylvania," has been nearly completed by Mr. Richardson.

## RHODE ISLAND.

In connection with the investigations of the stratigraphy, paleontology, underground water resources, and physiography of the Atlantic Coastal Plain, the examination of Cape Cod and the islands off the south coast of Massachusetts and Rhode Island, including Block Island, was undertaken by J. B. Woodworth.

A report, briefly describing the Rhode Island coal field and discussing in particular the composition and adaptations of the coals of the State, by G. H. Ashley, is in press as Bulletin 615.

## SOUTH CAROLINA.

The folio describing the areal and economic geology of the Kings Mountain and Gaffney quadrangles, in South and North Carolina, has been nearly completed by D. B. Sterrett, although minor field examinations at certain points may be needed before the folio can be finished.

The upper Cretaceous formations of South Carolina are discussed in the report by L. W. Stephenson on the worms and mollusks of the deposits of this age in the Carolinas. This report, which is ready for transmission; has been prepared in cooperation with the Geological and Economic Survey of North Carolina, by which it will be published.

A monograph on the Pliocene and Miocene Foraminifera of the Atlantic Coastal Plain, by Joseph A. Cushman, has recently been submitted for publication.

A paper by L. W. Stephenson, entitled "A deep well at Charleston, S. C.," with a report on the mineralogy of the water by Chase Palmer, has been published as Professional Paper 90-H.

## SOUTH DAKOTA.

The preparation of a report on the Upper Cambrian geology, Tertiary igneous rocks, and mineral resources of the Black Hills to accompany a quadruple folio covering the Deadwood, Rapids, Hermosa, and Harney Peak quadrangles was continued by Sidney Paige, who investigated the ore deposits of the region. By order of the Assistant Secretary of the Interior, Mr. Paige also examined certain mining claims in the Harney National Forest. The Paleozoic and younger sedimentary formations in these quadrangles are being described by N. H. Darton.

A field study of the stratigraphy of the Cretaceous and Eocene formations in the vicinity of Mobridge was made by T. W. Stanton for purposes of correlation.



## TENNESSEE.

In the Waynesboro quadrangle, Tennessee, some additional field examinations necessary to the completion of a folio were made by H. D. Miser, in cooperation with the Tennessee Geological Survey.

An investigation of the outcrops of the Clinton iron ore in the Cumberland Gap, Jonesville, Maynardsville, Morristown, Briceville, and Kingston quadrangles was made by E. F. Burchard, also in cooperation with the State, for the purpose of including the descriptions and maps of these deposits in a bulletin on the red iron ores of eastern Tennessee, northeastern Alabama, and northwestern Georgia.

The report on the Ducktown copper deposits is well advanced. The history and the descriptions of formations and structures have been written by F. B. Laney, and the description of the ore deposits by W. H. Emmons, but Mr. Emmons's part has not yet been adjusted to the part contributed by Mr. Laney and to that to be added by Arthur Keith.

In order more satisfactorily to classify and correlate the Paleozoic formations in portions of the State, sections were studied and numerous collections of invertebrate fossils were made in the eastern regions by R. D. Mesler and in central Tennessee by George H. Girty, in cooperation with H. D. Miser.

A brief field examination of the black shales at a number of points in Tennessee was made by G. H. Ashley, in connection with his study of the problem of the oil and gas resources ultimately to be realized through the distillation of these richly carbonaceous and widespread deposits.

A report on the fossil flora of the Jackson group, which covers a portion of the State, is in preparation by E. W. Berry, who also described the lower Eocene flora in Professional Paper 91, now in press.

In connection with the study of the post-Tertiary history and the physiography of the Mississippi embayment area an examination of the physiography and Quaternary geology of western Tennessee is in progress by E. W. Shaw.

In accordance with a plan for cooperating with the Bureau of Mines, the Bureau of Standards, and the Office of Public Roads in the investigation of the building materials of the United States, T. Nelson Dale examined the marble deposits of eastern Tennessee. This investigation was made in cooperation also with the State geological survey, which is expected to furnish areal and stratigraphic details, the data respecting the mechanical composition and the special characteristics and qualities of the marbles to be prepared by Mr. Dale. Physical tests of samples submitted have been furnished by the Bureau of Standards. The preparation of Mr. Dale's report is well advanced.



The phosphate deposits in the vicinity of Mount Pleasant, the center of the brown rock phosphate industry in the State, have received some preliminary field study by W. C. Phalen, who has brought up to date the mapping of the important deposits of brown rock, sampled the deposits for analyses, and studied the conservation of these important resources. The results of these studies will probably be included in a general economic report on the phosphate deposits of the southern Appalachian region.

In accordance with a cooperative arrangement between the Bureau of Mines, the Tennessee Geological Survey, and the United States Geological Survey, all the coal mines in Tennessee producing coal on a commercial scale and a number of small and intermittently operated coal mines were examined and sampled by the Geological Survey, all the samples being taken by one geologist, Frank R. Clark. The sampling was done according to the practice of the Geological Survey and the Bureau of Mines, which made the analyses. The analyses will probably be published by this Survey, by the State, and by the Bureau of Mines.

#### TEXAS.

A reconnaissance of the deposits of brown iron ores and iron carbonate ores in northeastern Texas was made by E. F. Burchard, whose report on the iron ores of Cass, Marion, Morris, and Cherokee counties is in press as Bulletin 620-E.

In connection with the investigation of nonmetalliferous mineral deposits in various regions, the supposed phosphate deposits in Brewster County were examined by W. C. Phalen, in company with J. A. Udden, of the bureau of economic geology and technology of the University of Texas. Mr. Phalen also inspected the cores of drillings made in exploration for sulphur at Bryan Heights. Observations noted in connection with these examinations are incorporated in his report on the production of sulphur for 1914.

In the Survey's investigation of all reported discoveries of potash salts samples have been taken for analysis at a number of points in Texas. Close attention is given to all borings in the "Red Beds" region of the State, and this Survey has offered to supplement the work of the State University through the field observation of drilling and the analyses of samples.

The relations of the Fayette, Catahoula, and Fleming formations in Texas were studied by G. C. Matson and Alexander Deussen, and a report on the Catahoula formation, prepared by Mr. Matson in cooperation with E. W. Berry, was transmitted for publication. Reports on the fossil flora of the Claiborne and Jackson groups were being prepared by Mr. Berry.

The manuscript for a report on the geology of the Coastal Plain of Texas west of Brazos River, by Alexander Deussen, is nearing

completion. The underground water supply of Lasalle and McMullen counties is discussed by Mr. Deussen and R. B. Dole in a report transmitted for publication by the water-resources branch (Water-Supply Paper 375-G).

Reconnaissance examinations, with special reference to the possible occurrence of oil or gas pools, were made by C. H. Wegemann, near Mineral Wells and Quanah, and reports containing the conclusions reached have been submitted for publication in the current volume of "Contributions to economic geology."

#### UTAH.

A general summary report on the ore deposits of Utah, by B. S. Butler and G. F. Loughlin, has been materially advanced during the year, and the authors expect to complete it during the coming year.

The Tintic district was revisited by Waldemar Lindgren and Mr. Loughlin to procure additional material for their report on the geology and ore deposits. This report has since been transmitted by the senior author for publication. Mr. Loughlin also made a brief visit to the Ophir district to study the occurrence of the zinc ores.

In response to a special request from mining men, Mr. Loughlin revisited Marysvale for the purpose of further examining the alunite deposits and later submitted a brief report. He also examined the ore deposits at Fortuna, near Beaver.

The search for uranium and vanadium deposits in southeastern Utah, begun by F. L. Hess but temporarily relinquished by him on account of illness, was continued by B. S. Butler, assisted by W. H. Whitehead, in Wayne, Garfield, and San Juan counties. In addition to examining the horizons at which uranium minerals are known to occur, the stratigraphy of the Colorado Plateau and Henry Mountains regions as interpreted by Dutton and Gilbert was reexamined, and correlations were made with areas farther north and east that had been mapped by C. T. Lupton and E. G. Woodruff.

A reconnaissance report on the Cottonwood-American Fork area by Messrs. Butler and Loughlin, with a section on the history of mining and production by V. C. Heikes, was submitted for publication (Bulletin 620-I).

The physiography and geologic history of the Colorado Plateau have been the subject of a general study by H. E. Gregory, which he expects to continue as opportunities arise and funds are available.

The occurrence of phosphate deposits in rocks of Mississippian age in the vicinity of Logan was investigated by E. H. Finch, whose report is in preparation.

A preliminary reconnaissance examination of the south and west slopes of the Uinta Mountains to determine whether or not phosphate is present and under what conditions it occurs was made by A. R. Schultz.

A brief examination of the salts in Salduro Salt Flat, with special reference to the possible presence of potash in commercial amounts, was made by Hoyt S. Gale.

The detailed survey begun in the Book Cliffs coal field at Sunnyside, Carbon County, in 1911, has been continued westward each succeeding year, and in the season of 1914 another 15-minute quadrangle, the Castle Gate, was covered. Nothing has yet been published on these areas, but an economic bulletin and a folio are in preparation for each quadrangle completed, namely, Sunnyside, Wellington, and Castle Gate. In this investigation the outcrop of each coal bed of economic value was traced and mapped by F. R. Clark, the geologist in charge, and many exact data were obtained regarding both horizontal and vertical locations of measured sections of the coal beds. In spite of the rugged character of the cliffs, which made the work difficult and laborious, an area of 230 square miles was examined in detail.

In addition to the Castle Gate quadrangle an area of about 80 square miles in Morgan County was examined in detailed reconnaissance by Mr. Clark to determine the possible occurrence of coal in commercial quantities. The land has been classified, and a short geologic report is now in preparation by Mr. Clark.

The ozokerite deposits near Colton, Soldier Summit, and Media were examined by H. M. Robinson, who has prepared and submitted for publication a report on the ozokerite deposits of Utah. The oil shale near Mount Pleasant was examined by Mr. Robinson in company with David T. Day, in cooperation with the Bureau of Mines.

A geologic report on the Emery coal field by C. T. Lupton has been submitted for publication, and a report on the Coalville coal field, by C. H. Wegemann, based on field work done in a previous year, has been published as Bulletin 581-E.

Some field observations of the ancient Lake Bonneville basin were made by G. K. Gilbert, in connection with his brief description of the history of the lake and of Great Salt Lake, for use in the Overland Route guidebook (Bulletin 612). In connection with the preparation of a discussion of the geologic structure in the Great Basin region, observations on the master faults associated with the mountain ranges were made by Mr. Gilbert.

#### VERMONT.

In the Bennington quadrangle, Vermont, detailed mapping was completed by L. M. Prindle. During this work Mr. Prindle was joined for a conference by Prof. G. H. Perkins, State geologist, and for a review of the work of Arthur Keith, who also discussed the geologic work of the Survey in Vermont with Prof. Perkins. Special investigation was made by Mr. Keith of the stratigraphy and faulted

structure of the Taconic Mountains in the Brandon, Rutland, Castleton, Pawlet, and Wallingford quadrangles for the purpose of solving some intricate problems involved in this work before the southern Vermont folios can be submitted for publication. A brief reconnaissance was made by Mr. Keith in the Ludlow and Brattleboro quadrangles.

The mapping of the Quaternary deposits of the Hoosic and Bennington quadrangles was completed by F. B. Taylor, who has nearly finished the descriptions to be incorporated in a folio covering these quadrangles. The field examination of the Quaternary deposits of the Pawlet and Equinox quadrangles was begun by Mr. Taylor.

#### VIRGINIA.

The detailed investigation and mapping of the southwestern Virginia coal field was continued in cooperation with the Virginia State Geological Survey. The geologic field examinations, which were contemporaneous with the topographic mapping and conducted from the topographic camp, were extended over the Virginia portions of the Hurley, Gilbert, Matewan, Iaeger, and Welch quadrangles. This work was in charge of Henry Hinds, who was assisted on the part of the State by T. K. Harnsberger. Progress was made on the Bucu and Clintwood geologic maps. The pre-Pennsylvanian rocks of the Bucu quadrangle were examined by G. W. Stose in company with Mr. Hinds.

For the purpose of comparing and correlating several of the older geologic formations in the region under detailed investigation, Mr. Hinds made a brief reconnaissance, with E. O. Ulrich and Charles Butts, of the formations exposed near Roanoke and Cleveland.

The preparation of a report embodying the results of the study of the coals in the Pocono formation of Virginia, which were examined the previous spring, was begun by R. W. Howell. This work was done in cooperation with the State Geological Survey.

In the Abingdon quadrangle detailed areal work on the Paleozoic formations was continued by G. W. Stose, who will describe and map most of them in the Abingdon folio, for which the pre-Paleozoic rocks will be treated by Arthur Keith. Although this project is not cooperative, Mr. Stose was joined for a time by T. L. Watson, State geologist, who, with F. A. Wilder, of the State Survey, is cooperating with Mr. Stose in the preparation of reports on salt and gypsum in the State.

A number of sections of the Devonian formations in southwestern Virginia were visited by Charles Butts, E. O. Ulrich, and R. D. Mesler, for the purpose of correlating the formations in this region with those in other regions and States of the Appalachian province.

A monograph describing the Tertiary Mollusca of Virginia and North Carolina has been completed by Miss Julia Gardner.

Mica deposits in Amelia and Hanover counties and an amethyst deposit in Louisa County were examined by D. B. Sterrett.

## WASHINGTON.

The Glacier coal field, in Whatcom County, Wash., was examined by M. R. Campbell for the purpose of classifying the land and valuing that which is underlain by workable coal. The report on this field, which was found to contain a considerable quantity of high-grade anthracite, has been delayed in the hope that additional prospecting would be done so as to afford fuller and more exact information relating to the coal.

Several small tracts near Molson were examined by E. L. Jones, jr., to ascertain their probable value for metal mining or agriculture. Mr. Jones also made a reconnaissance examination of about 100 square miles in the Conconully district.

A report describing the mineral deposits and geology of the Colville Indian Reservation, based on an examination made in previous seasons for purposes of classification, was submitted by J. T. Pardee for publication in "Contributions to economic geology."

## WEST VIRGINIA.

Some progress has been made in the preparation of a report on the semianthracite coal resources of the Pocono formation, in West Virginia, by R. W. Howell, but further work was postponed on account of the detail of Mr. Howell for investigations in the Mid-Continent oil region.

An examination was made by G. H. Ashley of the black shale at a number of points in the State in connection with an investigation of the value of such shale for distillation.

The survey of the Williamsport quadrangle, including parts of Maryland and Pennsylvania, was completed by G. W. Stose, and the results will be published in the Williamsport-Hagerstown folio. Mr. Stose and G. P. Grimsley, of the State Survey, held a field conference in this area, the State Survey being interested in this work, although not cooperating financially.

## WISCONSIN.

Special examinations of the glacial deposits of northwestern Wisconsin were made by Frank Leverett in October, 1914, and, together with Dr. Samuel Weidman, of the Wisconsin Geological and Natural History Survey, in June, 1915, in order to correlate the deposits in Minnesota with those in Wisconsin and to complete the data for a report on the extent and relations of the Superior ice lobe in Michigan, Wisconsin, and Minnesota.

An agreement has been made with Dr. Weidman for the completion of a folio covering the Wausau and Marathon quadrangles, in cooperation with the State Survey.



- Some additions were made to the manuscript on the Quaternary geology of southeastern Wisconsin, which was submitted for publication by W. C. Alden.

In cooperation with the geologists of the State Survey the stratigraphy and paleontology of the early Paleozoic formations were investigated by E. O. Ulrich.

#### WYOMING.

The areal mapping and the investigations relating to the possibilities of the presence of oil and gas in the structural domes and anticlines of central Wyoming between Casper and Lander, in Natrona, Fremont, and Carbon counties, commenced in 1913, was completed by C. J. Hares, assisted by J. B. Reeside, jr., and K. C. Heald. An area of about 2,800 square miles was covered, of which 1,940 miles was mapped in detail and the remainder in detailed reconnaissance. Special attention was given to the structure of the rocks and to the late Tertiary formations. The total area mapped in the two seasons is about 5,000 square miles, upon which a short preliminary report has been submitted for publication, and a final report is now being prepared.

In the eastern portion of the Bighorn Basin a detailed geologic examination was begun by C. T. Lupton, assisted by J. D. Northrop and W. P. Woodring, special attention being given to the structure of the rocks in order to discover those structures which are favorable to the accumulation of oil and gas. A preliminary report entitled "Oil and gas near Basin, Big Horn County, Wyo." (Bulletin 621-L) and a more detailed report on oil fields in the southern part of the Bighorn Basin have been submitted by Mr. Lupton.

Field work was resumed by C. F. Bowen in the Saddleback quadrangle, forming part of an examination made primarily for the purpose of classifying and valuing the coal lands embraced in the Saddleback, Hanna, and Walcott quadrangles. Exact horizontal and vertical locations were determined by plane-table methods for all sections measured on the coal beds as well as for geologic boundaries and structural features. Economic and folio reports for the Saddleback quadrangle are being prepared by Mr. Bowen.

In the Ilo, Oregon Basin, and Meeteetse quadrangles field examinations were completed by D. F. Hewett, who has submitted for publication an economic report covering the two quadrangles last named and is also preparing folios for the area examined. The geologic mapping was done by plane-table methods and independently of the topographic sketching, which was carried on simultaneously by the topographic branch.

The survey of the central part of the Powder River coal field and the reexamination of the Salt Creek oil field were begun by C. H. Wegemann and R. W. Howell.

Reconnaissance examinations were made of ore deposits in the North Laramie Mountains and of the Atlantic gold district, in the southeastern part of the State, by A. C. Spencer, who has transmitted a report on the North Laramie Mountain region and has in preparation his report on the Atlantic district.

A field study of the Bighorn limestone as exposed in the Wind River Mountains near Lander, in the Owl Creek Mountains, and in the Bighorn Mountains was made by Edwin Kirk.

An examination for phosphate was made by G. R. Mansfield in the Salt River region east of Star Valley. Data for the classification of the land in seven townships have been submitted by Mr. Mansfield, who has completed, for publication as a bulletin, a report on the economic resources of the region.

A report of a reconnaissance in southeastern Idaho and western Wyoming, with special reference to phosphate deposits, was submitted by A. R. Schultz.

#### CANAL ZONE.

The investigations made for the purpose of determining the geologic formations, their correlation, and the geologic history of the Canal Zone and adjacent regions of Panama and Costa Rica have been continued during the year, and most of the series of reports planned with the cooperation of the Smithsonian Institution, the Isthmian Canal Commission, and the United States Geological Survey are approaching completion. A manuscript describing the physiography, stratigraphy, geologic structure, geologic history, and economic geology of the Canal Zone and adjacent areas, by D. F. MacDonald, is about one-third completed. A report on the fossil calcareous algæ of the Canal Zone has been submitted by Dr. M. A. Howe, of the New York Botanical Garden, and reports on the Foraminifera and on the fossil Crustacea have been completed by Joseph A. Cushman and Miss M. J. Rathbun, respectively. Progress has been made in the report on the fossil plants of higher orders by E. W. Berry, on the fossil corals by T. W. Vaughan, on the fossil echinoids by R. T. Jackson, and on the fossil Bryozoa by R. S. Bassler and F. Canu. This series of reports, which will contain important conclusions as to geologic correlation and geologic history, will be published by the Smithsonian Institution.

#### ANTILLES.

A series of reports similar to those relating to the Canal Zone is in preparation for the Lesser Antillean Islands. The materials, largely paleontologic, submitted for study and the opportunities for field examinations are occasional and are possible only through the courtesy of private citizens, local governments, or scientific institutions. The systematic investigations, which are under the direction of



T. W. Vaughan, have been made possible through grants by the Carnegie Institution of Washington. Most of the cooperating geologists and paleontologists are not officers of the United States Geological Survey, but, besides Mr. Vaughan, who is studying the general physiography and general geology and is describing the fossil corals, C. Wythe Cooke has already prepared a report on the fossil Mollusca from the Lesser Antillean Islands and from Cuba. A report on the Foraminifera is in preparation by Joseph A. Cushman.

The investigations relating to the Canal Zone and the Antilles are of great importance to the understanding of the geology of both the eastern and western sides of continental North America, as only by accurate paleontologic knowledge of the West Indies and Central America can the geologic formations and the fossil associations on the two sides of the continent be correlated.

#### HAWAII.

A report by Whitman Cross on the "Lavas of Hawaii and their relations" has been published as Professional Paper 88.

### DIVISION OF ALASKAN MINERAL RESOURCES.

#### APPROPRIATION AND CLASSES OF WORK.

On April 6, 1914, \$100,000 was appropriated for the continuation of the investigation of the mineral resources of Alaska. The availability of funds at this early date made it possible to start the field work promptly and to carry it on economically, and the results were in strong contrast to those of the two previous years, when the delay in granting funds until summer greatly hampered the field work and made it very expensive.

The work carried on under this appropriation, as in previous years, included reconnaissance and detailed geologic and topographic surveys, special investigations of mineral resources, and the collection of statistics on mineral production.

#### PERSONNEL.

On July 1, 1914, the personnel of the division consisted of 1 geologist in charge, 11 geologists, 4 topographers, 3 clerks and 1 draftsman on annual salaries, 2 field assistants, and 22 camp hands and recorders. On June 30, 1915, the personnel included 1 geologist in charge, 11 geologists, 4 topographers, 1 engineer, 3 clerks, and 1 draftsman on annual salaries, 1 clerk on monthly salary, 2 geologists on per diem salary, 1 field assistant, and 28 camp hands and recorders.

## FIELD OPERATIONS DURING SEASON OF 1914.

*Areas covered and allotments.*—Ten parties were engaged in surveys and investigations during 1914. The area covered by exploratory geologic surveys, on a scale of 1: 500,000 (8 miles to the inch), amounts to 1,000 square miles; by reconnaissance geologic surveys, on a scale of 1: 250,000 (4 miles to the inch), 7,700 square miles; by detailed geologic surveys, on a scale of 1: 62,500 (1 mile to the inch), 325 square miles. Much of the time of the geologists was devoted to the investigation of special field problems in the important mining districts, the results of which can not be presented in terms of area. About 600 square miles was covered by exploratory topographic surveys on a scale of 1: 500,000, 10,300 square miles by reconnaissance topographic surveys on a scale of 1: 250,000, and 10 square miles on a scale of 1: 24,000 (2.64 inches to 1 mile).

The following table shows the allotment, including both field and office expenses, of the total appropriation to the districts investigated. In addition to this, a balance of about \$6,000 from last year's appropriation was expended in equipping the parties for the season's field work. In preparing this table the general office expenses were divided among the districts in proportion determined by the cost of the surveys in each district, allowance being made for variations in the character of the work. The results are expressed in round numbers. The "general investigations" include the cost of special studies of geology and mineral resources which were not of an areal character. The unallotted balance has been used for equipment of field parties and expenses up to the close of the fiscal year 1915.

*Approximate geographic distribution of appropriation for Alaska investigations, 1914.*

Southeastern Alaska.....	\$6, 000
Copper and Susitna basins.....	25, 000
Prince William Sound.....	6, 500
Kuskokwim and Mulchatna River basins.....	22, 000
White and Chisana River basins.....	14, 000
Yukon basin.....	2, 000
Seward Peninsula.....	1, 500
General field and office investigations.....	12, 000
Allotted to field investigations of 1915.....	11, 000
	<hr/>
	100, 000

In the following table the approximate amount of money devoted to each class of investigations and surveys is indicated. It is not possible to give the exact figures, as the same party or even the same man may have carried on two different kinds of work, but this statement will help to elucidate a later table, which will summarize the complete areal surveys.

*Approximate allotments to different kinds of surveys and investigations, 1914.*

Geologic and topographic exploration.....	\$4, 400
Geologic reconnaissance surveys.....	13, 000
Detailed geologic surveys.....	15, 600
Special geologic investigations.....	13, 000
Reconnaissance topographic surveys.....	22, 500
Detailed topographic surveys.....	4, 300
Collection of statistics.....	1, 400
Miscellaneous, including administration, inspection, clerical salaries, office supplies and equipment, and map compilation.	14, 800
Allotted to field investigations, 1915.....	11, 000
	<hr/> 100, 000

*Allotment for salaries and field expenses, 1914.*

Scientific and technical salaries.....	\$36, 530
Field expenses.....	36, 715
Clerical and other office and miscellaneous expenses.....	15, 755
Allotted to field investigations, 1915.....	11, 000
	<hr/> 100, 000

*Progress of work.*—The following table exhibits the progress of investigations in Alaska and the annual appropriations since systematic surveys were begun in 1898:

*Progress of surveys in Alaska, 1898-1914.*

\* The Coast and Geodetic and International Boundary surveys and the General Land Office have also made topographic surveys in Alaska. The areas covered by these surveys are, of course, not included in these totals.

*General work.*—Alfred H. Brooks, geologist in charge, was engaged in office work until July 6, when he started for Alaska. He visited Survey parties at Juneau, Valdez, Kotsina River, and Fairbanks, returning to Washington October 7.

George C. Martin was engaged during the summer on the Mesozoic stratigraphy of Alaska. Mr. Martin, accompanied by R. M. Overbeck as assistant, visited important localities in southeastern Alaska and in the Chitina and Yukon valleys. Arthur Hollick was employed for 64 days in continuing the study of Alaska Cretaceous and Tertiary floras.

R. H. Sargent continued the general supervision of the topographic surveys and map compilation in addition to carrying on his own field work. E. M. Aten continued as office assistant to the geologist in charge and supervised the office work during the field season. He also continued to assist in collecting statistics of the production of precious metals in Alaska.

*Southeastern Alaska.*—D. C. Witherspoon worked on detailed topographic surveys in the Juneau district. Rain prevented work on 45 days and greatly hampered it much of the rest of the season. Nevertheless, Mr. Witherspoon covered the area by triangulation and mapped 9.75 square miles on a scale of 1:24,000, with 50-foot contours. Mr. Eakin devoted about 10 days in the fall to the study of mining developments in the Juneau and Berners Bay districts.

*Copper River and Susitna basin.*—Detailed geologic mapping of the west end of the Kotsina-Chitina copper belt, begun in 1912, but interrupted in 1913, was completed in 1914 by F. H. Moffit, assisted by J. B. Mertie, who together mapped the geology and studied the mineral resources of an area of 185 square miles.

A topographic reconnaissance survey was carried by J. W. Bagley from Copper Center to the head of Klutina River and thence northwestward to the Susitna, an area of 4,000 square miles being surveyed by phototopographic methods, on a scale of 1:250,000, with 200-foot contours. Theodore Chapin, who accompanied the party as geologist, mapped an area of about 3,600 square miles. He also examined the gold placers of the Nelchina basin. This survey is an important connecting link between areas previously mapped in the Copper, Susitna, and Matanuska valleys.

*Prince William Sound.*—A detailed geologic survey and study of mineral resources of the Port Valdez district was begun in 1914 by B. L. Johnson, assisted by G. L. Harrington, covering 140 square miles.

*Lake Clark-Iditarod region.*—An exploration of the large, almost unknown region lying between Lake Clark and the Iditarod district was undertaken in 1914 by a party under R. H. Sargent, topographic engineer, and P. S. Smith, geologist. The topographic surveys

covered 4,800 miles and the geologic surveys 3,500 square miles. Some of the quicksilver deposits of the Kuskokwim region were also examined.

*Lower Kuskokwim basin.*—A. G. Maddren, assisted by Burt Kennedy, made a reconnaissance in the lower Kuskokwim basin. From Iditarod they went overland to Kuskokwim River, down that river, and up several tributary streams, making an examination of the Aniak-Tuluksak placer district and exploratory topographic surveys of about 600 square miles. Besides the gold placers, some copper and quicksilver deposits were examined.

*Seward Peninsula.*—In view of important developments in the York tin district a supplementary examination of this field was undertaken by H. M. Eakin, who also investigated the mining developments near Nome and made a brief study of the iron deposits in the Sinuk basin, about 40 miles from Nome.

*Yukon basin.*—Owing to the development of gold placers in the Chisana district in the upper Tanana Valley C. E. Giffin was detailed to extend the topographic surveys in this field. He surveyed Skolai Pass, extended the previous mapping in the Tanana and White River basins eastward to the international boundary, made reconnaissance surveys of about 1,500 square miles, for publication on a scale of 1:250,000, and revised about 1,500 square miles of the old mapping. The wagon road from Willow Creek to Chitina, a distance of 40 miles, together with the adjacent country, was also surveyed in the autumn, making an additional area of revision of about 150 square miles. S. R. Capps made a study of the Chisana placer district and mapped the geology of an adjacent area of about 600 square miles.

H. M. Eakin devoted about three weeks to the investigation of the mining developments in the Hot Springs and Fairbanks districts.

#### FIELD AND OFFICE WORK FOR SEASON OF 1915.

Alfred H. Brooks will continue his general geologic investigations in different parts of Alaska. G. C. Martin will complete the preparation of a report on the Mesozoic stratigraphy of Alaska. A. G. Maddren will complete reports on the Kuskokwim region, the Yakataga region, and the international boundary region in northeastern Alaska. Arthur Hollick will continue work on a report on Cretaceous and Mesozoic floras. G. A. Waring is investigating the hot springs of Alaska and will also collect data on the quality of the surface waters. D. C. Witherspoon is continuing the preparation of a new base map of the Juneau district on a scale of 1:24,000. The water powers of southeastern Alaska are being investigated by George H. Canfield, in cooperation with the Forest Service. Theodore Chapin is studying the geology and mineral resources of the Ketchikan district. A recon-

naissance geologic survey and investigation of the mineral resources of the upper Chitina basin is being made by F. H. Moffit and R. M. Overbeck. B. L. Johnson is completing a detailed geologic survey and study of the mineral resources of the Port Valdez district. He will later extend a reconnaissance geologic survey in the Prince William Sound region. Topographic and geologic reconnaissance surveys and investigations of mineral resources are being made in the Knik and Turnagain Arm region by J. W. Bagley and S. R. Capps. Time permitting they will also make similar surveys north of the Willow Creek district. Eliot Blackwelder is engaged in studying the Paleozoic stratigraphy of the upper part of the Yukon basin in Alaska. Topographic reconnaissance surveys of the Ruby district and the region lying to the south as far as Kuskokwim River are being made by R. H. Sargent and C. E. Giffin, and the geology and mineral resources of the same region are being studied by J. B. Mertie and G. L. Harrington. H. M. Eakin will explore the region lying between Cosna River, tributary to the lower Tanana, and the Ruby district, on the Yukon.

#### COLLECTION OF STATISTICS.

The work of collecting statistics of the annual production of gold, silver, and copper, begun in 1905, was continued during the year. Preliminary estimates of mineral production were published on January 1, 1915. The progress report for 1914 (Bulletin 622), containing figures on mineral production, was transmitted in June. An abstract of this report, including the mineral statistics, was also transmitted in June for inclusion in the Survey's annual volume, Mineral Resources of the United States, for the calendar year 1914.

#### PUBLICATIONS.

During the year one professional paper (No. 87), three bulletins (Nos. 576, 578, 592), one water-supply paper (No. 342), and one separate of a water-supply paper (No. 345-F) relating to Alaska were issued.

Two Alaska maps were issued for sale—a general map of Alaska (scale 1:1,500,000) and a map of the Port Valdez district (scale 1:62,500).

Three bulletins (Nos. 605, 607, 608), one water-supply paper (No. 372), and one separate of a professional paper (No. 95-D) are in press. Manuscripts of the following reports have been completed: Mineral resources of Alaska, report on progress of investigations in 1914, by Alfred H. Brooks and others (Bulletin 622); the Yukon-Koyukuk region, Alaska, by H. M. Eakin; and the Chisana-White River district, Alaska, by S. R. Capps.

The following reports are in hand:

Geology of the Glacier Bay and Lituya region, Alaska, by F. E. Wright and C. W. Wright, including geologic reconnaissance map.

The Lake Clark-Iditarod region, Alaska, by P. S. Smith.

The Kotsina-Kuskulana district, Alaska, by F. H. Moffit.

The lower Kuskokwim region, Alaska, by A. G. Maddren.

The Nelchina-Susitna region, Alaska, by Theodore Chapin.

The Yakataga district, Alaska, by A. G. Maddren.

The upper Matanuska basin, Alaska, by G. C. Martin.

The Mesozoic stratigraphy of Alaska, by G. C. Martin.

Geology of the region along the international boundary, Alaska, from Porcupine River to the Arctic Ocean, by A. G. Maddren, including detailed geologic map.

The Cretaceous and Mesozoic floras of Alaska, by Arthur Hollick.

The office work on the three topographic maps named below, besides the three noted above as issued, were completed:

Broad Pass region, by J. W. Bagley; scale 1 : 250,000; contour interval 200 feet.

Matanuska Valley, by R. H. Sargent; scale 1 : 62,500; contour interval 100 feet.

Relief map of Alaska, compiled by J. H. Renshawe; scale 1 : 1,500,000.

The following maps are in hand:

Kotsina-Kuskulana district, by D. C. Witherspoon; scale 1:62,500; contour interval 100 feet.

Lake Clark-Iditarod region, by R. H. Sargent; scale 1:250,000; contour interval 200 feet.

Chisana-White River region, by C. E. Giffin; scale 1:250,000; contour interval 200 feet.

Nelchina-Susitna region, by J. W. Bagley; scale 1:250,000; contour interval 200 feet.

Juneau mining district, by D. C. Witherspoon; scale 1:24,000; contour interval 50 feet.

Lower Kuskokwim region, by A. G. Maddren; scale 1:500,000; contour interval 500 feet.

Yukon-Tanana region (compiled); scale 1:500,000; contour interval 500 feet.

#### SCIENTIFIC RESULTS.

Mr. Martin's investigations of the Mesozoic stratigraphy have shown that there is a wide development of Upper Triassic strata in southeastern Alaska, part of the supposed Carboniferous limestones having proved to be of Triassic age; that marine Upper Cretaceous rocks are well developed in the Chitina Valley, where no marine strata younger than the Jurassic had previously been recognized, and that the Upper Cretaceous plant-bearing beds extend up the Yukon Valley nearly to the Canadian boundary.

Mr. Maddren discovered some fossiliferous Upper Carboniferous limestones and tuffs on Kuskokwim River, many miles from any previously known Carboniferous rocks.

Mr. Capps has found a Devonian fauna in the older volcanic rocks of the Chisana district, apparently in the same general belt as the



Devonian locality discovered by Messrs. Moffit and Pogue at Broad Pass in 1913, though many miles distant. These two are the only known occurrence of Devonian rocks south of the Alaska Range, except in southeastern Alaska.

Mr. Capps discovered evidence of an older epoch of glaciation in the upper White River basin. Here there is an indurated tillite which has been more or less folded and antedates the glaciation that produced the present land forms. In the Lake Clark-Kuskokwim basin Mr. Smith found that the westward limit of glaciation was nearer the Kuskokwim than had been previously supposed. Mr. Maddren found evidence of a locally glaciated area in the mountains southeast of lower Kuskokwim River.

#### DIVISION OF CHEMICAL AND PHYSICAL RESEARCH.

This division is in charge of George F. Becker, geologist, who has immediate direction of geophysical researches. The staff in the chemical laboratory forms essentially a section in charge of F. W. Clarke, chief chemist.

The work of the chemists has consisted for the most part of routine analyses of specimens submitted to the division for determination. During the year 423 quantitative analyses and 869 qualitative determinations have been made. Nevertheless, it has been possible to carry on some researches connected with the geologic problems on which the Survey is engaged.

Continuing the investigation of the composition of the hard parts of various invertebrates living in the cold and in the warm waters of the seas, in order to ascertain the conditions under which magnesium carbonate is deposited in large amounts instead of calcium carbonate, analyses of the fossil remains of a number of brachiopods, corals, alcyonarians, and other marine animals were made by W. C. Wheeler under Mr. Clarke's direction. A paper by Mr. Clarke and Mr. Wheeler on the composition of the brachiopod shells was published in the Proceedings of the Washington Academy of Sciences. Another contribution giving the results of the analyses of the fan corals is now in preparation.

In addition to his administrative work in the laboratory, Mr. Clarke has revised and brought up to date the material for the third edition of "The data of geochemistry" (Bulletin 616). The second edition, published as Bulletin 491, was printed in 1911.

Some research work on the methods of separating vanadium from large quantities of chromium has been pursued by George Steiger, whose time, however, has been mostly taken up by routine analyses, the purchase of supplies, and other administrative duties.

In making analyses of rocks submitted by Survey geologists, R. C. Wells found that water from a mine near Idaho Springs, Colo.,

resembling ink in appearance, owed its color to the presence of nearly 8 grams of molybdenum oxide per liter; also that a rich gold ore from Goodsprings, Nev., was essentially a plumbojarosite, containing 0.22 per cent palladium and 0.05 per cent platinum. In separating salts from the water of Great Salt Lake, Mr. Wells found that in the interval between  $0^{\circ}$  and  $-1^{\circ}$  C. the salt that separates is the mineral mirabilite,  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ . A manuscript entitled "The fractional precipitation of some ore-forming compounds at moderate temperatures" was completed by Mr. Wells for publication as Bulletin 609.

As the result of his continued chemical studies of silver enrichment, Chase Palmer, who has been associated with Edson S. Bastin, of the division of geology, in the field investigations, published two papers—"Bornite as silver precipitant," in the Journal of the Washington Academy of Sciences, and "Tetranickel-triarsenide, its capacity as silver precipitant," in Economic Geology and in *Zeitschrift für Kristallographie und Mineralogie*. The research in silver enrichment, begun by the section of metalliferous deposits of the division of geology, is still in progress.

A report on the mineralogy of artesian well waters beneath Charleston, S. C., published in Professional Paper 90-H, contains a simplified statement by Mr. Palmer of the principles of the geochemical interpretation of water analyses. A part of Mr. Palmer's time has been given to routine quantitative and qualitative analyses of minerals and quantitative analyses of waters.

An extensive study of the vanadium minerals was made by W. T. Schaller. Analyses were made of several vanadium minerals from Utah and two new species from Peru, and of a new copper silicate from Arizona. Mr. Schaller also determined the optical properties of all the available gahnites. He made a field study of the granitic pegmatite intrusions near Pala, San Diego County, Cal., and of a reported occurrence of tin ore in the same county.

A number of analyses of phosphate rock and other miscellaneous analyses were made by W. C. Wheeler, whose work in association with Mr. Clarke has already been mentioned.

Special attention has been given by W. B. Hicks to the analyses of salts. Complete analyses were made of 13 brines, 3 salt samples, and 1 specimen of alunite, partial analyses of 80 samples, and qualitative examinations of about 85 samples. Mr. Hicks also carried on some experimental work on the solubility of minerals in solutions of ammonium chloride and on the evaporation of brines from Searles Lake, Cal. A paper on "Evaporation of potash brines" (Professional Paper 95-E) was submitted by him for publication by the Survey, and another on "Solubility of mixtures of sodium chloride and potas-

sium chloride in solutions of hydrochloric acid" was published in the Journal of the American Chemical Society.

A great many miscellaneous analyses, including about 30 complete analyses of rocks, brines, salts, and waters, and 78 partial analyses of brines, muds, nitrates, and waters, were made by R. K. Bailey, who also gave one hour each day to assisting geologists in testing and identifying minerals. Some improvements in the apparatus and methods used in the laboratory for analytical work were devised by Mr. Bailey.

The work of the physical laboratory has consisted chiefly of the continuation of geophysical investigations noted in previous reports. In addition to his administrative work G. F. Becker carried on studies of isostasy, in connection with which he published in the Journal of the Washington Academy of Sciences a paper on the "Mean density of fractured rocks." The experimental data for this paper were determined by A. F. Melcher, and are described by him in a "Note on the change of density of sulphur with rupture," issued in the same publication. Mr. Melcher shows that some of the principal orogenic phenomena are due to decrease in the density of rocks under confinement through the production of cracks and to increase of density through infiltration. "Isostasy and radioactivity" was the subject of a presidential address by Mr. Becker before the Geological Society of America. In this address he drew the conclusions that not more than about a quarter of the heat emitted by the earth can be due to radioactivity and that the ages of minerals as determined by radiologists are untrustworthy. In this address and in a paper in the Proceedings of the National Academy of Sciences he concludes that the outer shell of the earth beneath continental areas is in fact an imperfect heat engine, which furnishes the energy manifested in upheaval, subsidence, and orogeny.

In consultation and cooperation with Prof. P. W. Bridgman, of Harvard University, Mr. Becker furnished hollow cylinders of rock-forming minerals for use in pressure tests. These Prof. Bridgman subjects to hydrostatic pressure of many thousand kilograms per square centimeter with highly interesting but at as yet incomplete results. Acknowledgments are due the Bureau of Standards for courteous cooperation in the preparation of these cylinders.

The conduction of heat out of an unevenly heated globe was investigated by Mr. Becker in the hope of elucidating conditions in high latitudes.

Work on the construction of mathematical tables, experiments on the diffusion of solids, and measurements of the temperatures of deep wells were continued by C. E. Van Orstrand, assisted by A. F. Melcher and A. T. Harris. Progress has been made in preparing a volume of tables of the probability integral and related functions

The first of these is the fact that the Survey has been organized on a basis of specialization. The various branches of the Survey are now so distinct and so numerous that it is impossible for any one man to be conversant with all of them. This is a great advantage, for it allows each branch to develop its own methods and to employ the most competent men for its work. It also allows the Survey to take advantage of the latest scientific discoveries and to apply them to its work. The second of these is the fact that the Survey has been organized on a basis of efficiency. The various branches of the Survey are now so distinct and so numerous that it is impossible for any one man to be conversant with all of them. This is a great advantage, for it allows each branch to develop its own methods and to employ the most competent men for its work. It also allows the Survey to take advantage of the latest scientific discoveries and to apply them to its work.

The third of these is the fact that the Survey has been organized on a basis of economy. The various branches of the Survey are now so distinct and so numerous that it is impossible for any one man to be conversant with all of them. This is a great advantage, for it allows each branch to develop its own methods and to employ the most competent men for its work. It also allows the Survey to take advantage of the latest scientific discoveries and to apply them to its work.

THE UNITED STATES GEOLOGICAL SURVEY

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During the last 10 years the separate branches have been organized into a single body of geologists of the Survey who have specialized in the various branches of the Survey with a view to carrying out the purposes of the Survey which is now the examination of the resources and products of the national domain.

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and, so far as applied, saves the producers the annoyance of preparing two sets of statistical returns.

During the fiscal year the report for 1913 was published in two parts—Part I (metals) in January and Part II (nonmetals) in February. Work on the report for 1914 was well advanced at the close of the year, 20 chapters having been completed and transmitted to the printer.

After the outbreak of the European war interest rapidly increased in the foreign supplies of mineral products needed in this country and also in domestic resources to supplant products hitherto imported and to fill war demands. A number of statements covering these subjects were immediately prepared for the press, and the division has carried on a large correspondence, furnishing to requesters detailed information in regard to our mineral resources which could not be covered in general publications, such as locations of deposits of minerals wanted and names and addresses of producers.

Preliminary estimates of the production of arsenic, cement, coal, copper, gold and silver, iron ores, lead, petroleum, quicksilver, radium ores, rutile, tungsten ores, uranium ores, vanadium ores, western metals, and zinc in 1914, with reviews of the conditions that prevailed during the year, were given to the press in the form of special press bulletins during the later part of December, 1914, and in January, 1915. Advance statements giving the final figures covering the production of copper, lead, and zinc in 1914 have also been published.

The number of permanent employees in Washington who devote their entire time to the work of the division of mineral resources is 31, and 8 persons are employed in the offices of the division at Salt Lake City, Denver, and San Francisco. In addition to these employees, 21 members of other divisions of the Survey, chiefly geologists, devote a part of their time to the work of the division, making a total of 60 persons employed in the work.

During the year 192,273 pieces of first-class mail matter were sent in inquiries for information needed for the reports, and 10,000 replies in increasing quantity. Replies to inquiries made for statistical information were sent out by the division 10,000 in 1914, and 65,491 pieces were received.

E. W. Parker continued as administrator, and as chief of the section of nonmetallic resources. He resigned his position, to take a responsible position in the private interests. Mr. Parker's departure is a great loss to the Geological Survey. As the coal statistician, and as chief of the division, he has set a high standard of "Mineral Resources" reports.

He has also done valuable work in the field of conservation and has published

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many papers on coal mining and production. It is fortunate that in his new field Mr. Parker will continue his work on these subjects, on which he has long been regarded an authority.

Mr. Parker's resignation became effective July 1, and H. D. McCaskey, geologist in charge of the metals section of the division, became geologist in charge of the division. Mr. McCaskey brings to his new position experience not only as a geologist of the Survey since 1907 and as section chief since 1912, but also as a mining engineer in the Philippine mining bureau from 1900 to 1903 and as chief of that bureau from 1903 to 1906.

C. E. Leshar, a geologist of the Survey, who has had extensive field and office experience and for two years and a half was vice chairman of the coal board of the land-classification board, succeeds Mr. Parker in the work on coal and coke.

On August 31 David T. Day, who for 21 years was chief of the division and for seven years was in charge of the preparation of reports on asphalt and bituminous rock, natural gas, petroleum, and platinum and allied metals, resigned. Dr. Day had taken large part in the constructive administration of the division, and his separation from the service removes another man of broad experience. John D. Northrop, a geologist of the Survey who has become familiar with the general trend of the petroleum industry by many years in geologic work in the oil fields of the United States, has taken up the work on asphalt and bituminous rock, petroleum, and natural gas.

During the year Mr. Parker prepared for publication by the Survey the report on the fuel-briquetting industry and a general review of the mineral products of the United States. The reports on the several mineral products were in charge of the following persons:

*Authors of chapters in Mineral Resources.*

Author.	Subject.
E. S. Bastin.....	Graphite.
E. F. Burchard.....	Cement, fluorspar and cryolite, iron ore, pig iron, and steel.
B. S. Butler.....	Copper (general report), copper and silver in Michigan (mines report).
A. T. Coons.....	Slate.
C. A. Davis (of the Bureau of Mines).	Peat.
J. S. Diller.....	Asbestos, chromite, talc, and soapstone.
R. B. Dole.....	Mineral waters.
J. P. Dunlop.....	Silver, copper, lead, and zinc in the Central States, except Michigan (mines report); secondary metals, metals and ores (summary report), gold, silver, copper, lead, and zinc in the Eastern States (mines report), quick-silver.
H. S. Gale.....	Borax, magnesite (with C. G. Yale), nitrates.
C. N. Gerry.....	Gold, silver, copper, lead, and zinc in Idaho and Washington (mines report).
V. C. Heikes.....	Gold, silver, copper, lead, and zinc in Arizona, Montana, Nevada, and Utah (mines report).
C. W. Henderson.....	Gold, silver, copper, lead, and zinc in Colorado, New Mexico, South Dakota, Texas, and Wyoming (mines report).
F. L. Hess.....	Antimony, arsenic, bismuth, cobalt, molybdenum, nickel, selenium, tantalum, tungsten, titanium, vanadium, uranium, tin.
D. F. Hewett.....	Manganese and manganiferous ores.
J. M. Hill.....	Barytes, mineral paints, platinum and allied metals, strontium ore.
F. J. Katz.....	Abrasives, feldspar, silica (quartz).
C. E. Leshar.....	Coal, and the manufacture of coke.



*Authors of chapters in Mineral Resources—Continued.*

Author.	Subject.
H. D. McCaskey.....	Gold and silver (general report), summary of mineral products, quick-silver.
Jefferson Middleton.....	Clay, clay-working industries, fuller's earth, sand-lime brick.
J. D. Northrop.....	Asphalt and bituminous rock, natural gas, petroleum.
W. C. Phalen.....	Bauxite and aluminum, phosphate rock, potash salts, salt and bromine, sodium salts, sulphur and pyrite.
C. E. Siebenthal.....	Lead, zinc, and cadmium (general reports).
D. B. Sterrett.....	Gems and precious stones, mica.
G. F. Loughlin.....	Building stone, glass sand, other sand and gravel, gypsum, lime.
C. G. Yale.....	Borax, magnesite (with H. S. Gale), gold, silver, copper, lead, and zinc in California and Oregon (mines report).

Mr. McCaskey also has general supervision of the offices of the division in the Western States. These offices act as Survey bureaus of information and are under the direct charge of C. W. Henderson, V. C. Heikes, and C. G. Yale, who also prepare the mines reports on gold, silver, copper, lead, and zinc in the Western States.

**TOPOGRAPHIC BRANCH.****ORGANIZATION.**

The organization of the topographic branch is as follows:

Chief geographer, R. B. Marshall.

Atlantic division, Frank Sutton, geographer in charge.

Central division, W. H. Herron, geographer in charge.

Rocky Mountain division, Sledge Tatum, geographer in charge.

Northwestern division, T. G. Gerdine, geographer in charge.

Pacific division, G. R. Davis, geographer in charge.

Inspectors of topography, J. H. Renshawe, geographer; W. M. Beaman and A. M. Walker, topographic engineers.

**PERSONNEL.**

The technical corps of the topographic branch was reduced 7 during the year by death and by resignations. With these changes the corps now includes 1 chief geographer, 9 geographers, 40 topographic engineers, 18 topographers, 41 assistant topographers, 42 junior topographers, and 8 draftsmen—a total of 159. In addition, 37 technical field assistants were employed during a whole or part of the field season. One topographic engineer, 1 topographer, 3 assistant topographers, 6 junior topographers, and 1 draftsman are on furlough. The clerical force comprises 1 senior clerk and 11 clerks of lower grades.

**PUBLICATIONS.**

The published work of the topographic branch for the year consists of 107 maps, which are listed on pages 36–37, and 11 book publications, namely, "Topographic instructions of the United States Geological Survey," edition of 1915, and bulletins giving results of spirit leveling



in Hawaii, Idaho, Iowa, Maryland, Michigan, Minnesota, Nebraska, Utah, Virginia, and Wisconsin. Brief summaries of these bulletins are given on page 21. Manuscripts for results of triangulation and primary traverse in the United States, 1913-1915, and of leveling in Arkansas, Georgia, Louisiana, Maine, Mississippi, New Mexico, South Dakota, Texas, and West Virginia were transmitted for publication.

ALLOTMENTS.

The total appropriations for topographic surveys for the fiscal year 1915 were:

Topographic surveys.....	\$350,000
Surveying national forests.....	75,000
Statutory salaries.....	9,200
	<hr/>
	434,200

The allotments of the appropriations, which were adhered to so far as practicable, were as follows:

*Allotments from funds appropriated for topographic work, fiscal year 1915.*

	Topo- graphic surveys.	Surveying national forests.
Administrative expenses of Survey.....	\$22,896	\$4,500
Clerical assistance and supervision.....	15,670	3,210
Map editing.....	6,225	1,275
Purchase and repair of instruments, stationery, etc.....	12,242	2,508
Millionth-scale map.....	20,000	.....
Field work:		
Atlantic division.....	66,000	.....
Central division.....	53,000	.....
Rocky Mountain division.....	63,922	19,745
Northwestern division.....	36,000	26,462
Pacific division.....	54,045	15,000
Work by land-classification board.....	9,000	2,500
	<hr/>	<hr/>
	359,000	75,200

COOPERATION.

Cooperation has been maintained with several States, as indicated below.

*Allotments made by States for cooperative work.*

Alabama.....	\$3,032.78
California (Department of Engineering).....	14,000.00
Illinois.....	9,000.00
Iowa.....	1,950.00
Kentucky.....	10,000.00
Maine.....	4,000.00
Michigan.....	2,500.00
Minnesota.....	4,500.00
Missouri.....	5,221.74
New York.....	10,000.00

Ohio.....	\$35,000.00
Oklahoma.....	1,000.00
Oregon.....	18,000.00
Pennsylvania.....	4,000.00
Texas.....	35,000.00
Vermont.....	2,000.00
Virginia.....	4,500.00
Washington.....	11,500.00
West Virginia.....	6,758.20
Wisconsin.....	4,000.00
Hawaii.....	837.35
	<hr/>
	186,800.07

In addition to the amounts given above, the State of Virginia allotted \$485 to cover one-half the cost of the compilation of the Virginia portion of the 1:1,000,000 scale map of the United States, and the city of Los Angeles, Cal., allotted \$2,500 for one-half the cost of the topographic survey of the Elizabeth Lake quadrangle.

#### GENERAL OFFICE WORK.

Progress maps were kept up to date and new ones were compiled when necessary, the new 1:500,000 State maps were used when available, and results of computations for vertical and horizontal control work were copied and catalogued.

The computations of control data were made principally by D. H. Baldwin, T. M. Bannon, C. E. Cooke, J. R. Ellis, G. T. Hawkins, Oscar Jones, C. B. Kendall, F. J. McMaugh, A. C. Roberts, J. H. Wilson, Fred McLaughlin, J. F. McBeth, and J. I. Gayetty under the immediate supervision of E. M. Douglas, geographer. Computing by L. F. Biggs and C. F. Urquhart was done in the Sacramento office. S. S. Gannett, geographer, was engaged in preparing manuscript and compiling data for the bulletins submitted for publication, in miscellaneous computations, and in furnishing triangulation and leveling data for field and office use.

J. H. Renshawe was engaged during a portion of the time in preparing for the Secretary of the Interior colored relief maps of Mount Rainier, Mesa Verde, and Rocky Mountain national parks. He also prepared a colored relief map of San Francisco and vicinity, a relief map of Alaska for the division of Alaskan mineral resources, and a small model to show the Survey's work for use in preparing a large model for the exhibition at San Francisco.

In the preparation of the special topographic maps used in the four transcontinental guidebooks the available Survey atlas sheets were used, and where such sheets were not available the data were filled in on field sheets on a scale of 5 miles to the inch. The different railroads assisted in every way possible, supplying all available profile and alignment data and rendering other valuable assistance. The

maps were published on a scale of 1:500,000, or about 8 miles to the inch, and cover routes as follows:

The Northern Pacific Route, over the Northern Pacific Railway from St. Paul, Minn., to Seattle, Wash., with a branch from Livingston to Gardiner, Mont., at the north entrance to Yellowstone National Park (Bulletin 611).

The Overland Route, over the Union Pacific and Southern Pacific railroads from Omaha, Nebr., to San Francisco, with a branch from Ogden, Utah, over the Oregon Short Line, to the west entrance to Yellowstone National Park (Bulletin 612).

The Santa Fe Route, over the Atchison, Topeka & Santa Fe Railway from Kansas City, Mo., to Los Angeles, Cal., with a branch from Williams, Ariz., to the Grand Canyon (Bulletin 613).

The Shasta Route, over the Northern Pacific and Southern Pacific railroads from Seattle, Wash., to San Francisco, and the Coast Line, over the Southern Pacific Railroad from Los Angeles to San Francisco (Bulletin 614).

#### SUMMARY OF RESULTS.

The condition of topographic surveys to June 30, 1915, distinguished as to scale, etc., is shown on Plate II.

As shown in the following tables, the total new area mapped was 20,508 square miles, making the total area surveyed to date in the United States 1,218,290 square miles, or 40.2 per cent of the entire country. In addition, 3,048 square miles of resurvey was completed, making the total area of surveys during the year 23,556 square miles.

In connection with these surveys, 6,952 linear miles of primary and precise levels were run, making 254,359 miles of primary and precise levels run since the authorization of this work by Congress in 1896. In the course of this work, 1,747 permanent bench marks were established. In addition, 498 linear miles of river surveys were run.

Triangulation stations to the number of 252 were occupied and 158 were permanently marked. Primary traverse lines aggregating 2,105 miles were run, in connection with which 356 permanent marks were set. In the course of this work 32,400 square miles were covered by primary control.

The area covered by topographic surveys in Alaska during the fiscal year, as reported in detail on page 93, was 10,910 square miles.

Topographic surveys were also carried on in Hawaii, the area mapped during the fiscal year being 19 square miles, for publication on the scale of 1:31,680, making the total area surveyed to date in Hawaii 1,393 square miles.

The average cost per square mile of the work done was \$22, the cost ranging from a little less than \$4 in the Elizabeth Lake (Cal.) quadrangle to over \$227 on the Sabine River project, Texas. Sixty per cent of the funds was expended in the public-land States.



1

2

*Present condition of topographic surveys of the United States and new areas surveyed July 1, 1914, to June 30, 1915.*

	New area mapped July 1, 1914, to June 30, 1915.	Total area mapped to June 30, 1915.	Percentage of total area of State mapped to June 30, 1915.
	<i>Sq. miles.</i>	<i>Sq. miles.</i>	
Alabama.....	440	19,192	37
Arizona.....	932	68,996	61
Arkansas.....		21,380	40
California.....	3,592	114,708	72
Colorado.....	1,439	48,783	47
Connecticut.....		4,965	100
Delaware.....		1,202	51
District of Columbia.....		70	100
Florida.....	259	2,339	4
Georgia.....		17,337	29
Idaho.....	687	26,185	31
Illinois.....	539	14,551	26
Indiana.....	191	3,441	9
Iowa.....	119	11,652	21
Kansas.....		64,159	78
Kentucky.....		17,973	44
Louisiana.....	8	8,319	17
Maine.....	151	9,361	28
Maryland.....		12,327	100
Massachusetts.....		8,266	100
Michigan.....	273	6,018	10
Minnesota.....	454	6,541	8
Mississippi.....	237	2,126	4
Missouri.....	544	36,710	53
Montana.....	557	57,163	39
Nebraska.....		26,524	34
Nevada.....	53	51,115	46
New Hampshire.....		3,380	36
New Jersey.....		8,224	100
New Mexico.....	1,315	37,247	30
New York.....	613	43,553	89
North Carolina.....	82	18,390	35
North Dakota.....		9,716	14
Ohio.....	2,818	40,018	97
Oklahoma.....	83	39,851	57
Oregon.....	1,771	23,406	24
Pennsylvania.....	262	24,908	55
Rhode Island.....		1,248	100
South Carolina.....		5,640	18
South Dakota.....		18,594	24
Tennessee.....		21,153	50
Texas.....	99	67,782	25
Utah.....	507	68,797	81
Vermont.....	224	4,190	44
Virginia.....		29,980	70
Washington.....	1,432	26,033	38
West Virginia.....		24,170	100
Wisconsin.....	270	12,203	21
Wyoming.....	557	28,404	29
Hawaii.....	20,508 19	1,218,290 1,393	40.2 22

## ATLANTIC DIVISION.

## FIELD WORK.

*Summary.*—During the season topographic mapping was carried on in Alabama, Florida, Georgia, Maine, Mississippi, New York, North Carolina, Pennsylvania, Tennessee, Vermont, Virginia, and West Virginia, and in a small area in Arkansas. This work comprised the completion of the survey of 11 quadrangles and of the resurvey of 5 quadrangles, in addition to which 7 quadrangles were partly surveyed and 7 were partly resurveyed. The total new area

mapped was 2,276 square miles, for publication on the scale of 1 : 62,500. The area resurveyed was 1,083 square miles, for publication on the scale of 1 : 62,500. The map of one quadrangle was partly revised, the area covered by this revision being 13 square miles. In connection with this work 1,268 miles of primary levels were run and 332 permanent bench marks were established.

Primary triangulation and primary traverse were carried on at different times by seven parties, the work being distributed over portions of Louisiana, Maryland, New York, and West Virginia. The total area covered by this primary control was about 2,200 square miles—1,000 square miles by primary traverse, 336 miles being run and 36 permanent marks set. Twenty-four triangulation stations were occupied and 4 were permanently marked. This work made control available in 17 quadrangles.

*Topographic surveys in Atlantic division from July 1, 1914, to June 30, 1915.*

State.	Con- tour inter- val.	For publication on scale of 1 : 62,500.		Total area sur- veyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Re- survey.		Dis- tance run.	Bench marks.	Dis- tance run.	Perma- nent marks.	Sta- tions occu- pled.	Stations marked.
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>			
Alabama.....	20	440	99	539	144	36				
Arkansas.....					42	3				
Florida.....	20	259		259						
Georgia.....	50		38	38						
Louisiana.....	10	8		8	55	13	86	12		
Maine.....	20	151	163	314	15	3				
Maryland.....							34	2		
Mississippi.....	10	237		237	116	34				
New York.....	20	613		613	443	116	117	12	9	4
North Carolina.....	20	82		82						
Pennsylvania.....	20	262		262	114	44				
Tennessee.....					56	5				
Vermont.....	20	224		224	67	17				
Virginia.....	50		317	317	101	27				
West Virginia.....	20		466	466	115	34	99	10	15	
		2,276	1,083	3,359	1,268	332	336	36	24	4

*Alabama.*—As stated in the previous annual report, the State geologist of Alabama allotted \$10,000 to cover the cost of unfinished cooperative work done in 1911-12, when under a cooperative agreement to spend \$10,000 each \$7,024.93 was expended by the Federal Survey and nothing by the State, whose funds were not available. During the year, after \$3,032.78 had been expended, State cooperation ceased and the work was completed with Federal funds amounting to \$5,932.15. The survey of the Muscle Shoals and Center Star quadrangles in Colbert, Lauderdale, and Lawrence counties, was completed, and that of the Gravelly Springs quadrangle, in Lauderdale County, was begun by C. E. Cooke, W. H. S. Morey, T. F. Slaughter, C. S. Wells, F. W. Crisp, and R. H. Kilmer, the area mapped being



440 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Center Star quadrangle Mr. Kilmer ran 66 miles of primary levels and established 17 permanent bench marks.

In addition to the cooperative work the resurvey of the Weogufka quadrangle in Coosa, Shelby, and Talladega counties was commenced by Duncan Hannegan, W. H. Griffin, W. H. S. Morey, J. B. Metcalfe, jr., C. S. Wells, and C. W. Arnold, the area mapped being 99 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of this area H. S. Senseney ran 78 miles of primary levels and established 19 permanent bench marks.

*Arkansas.*—(See Tennessee-Arkansas, p. 113.)

*District of Columbia-Maryland-Virginia.*—During the year the culture on the map of Washington and vicinity was revised in the field. In connection with this work C. B. Kendall and C. A. Ecklund ran 34 miles of primary traverse and set two permanent marks.

*Florida.*—The survey of the Interlachen quadrangle, in Marion and Putnam counties, was completed by W. H. Griffin, J. B. Metcalfe, jr., and C. W. Arnold, the area mapped being 259 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

*Georgia.*—The resurvey of the Talking Rock quadrangle, in Gilmer, Gordon, Murray, and Pickens counties, was completed by E. I. Ireland, K. W. Trimble, and H. S. Senseney, the area mapped being 38 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet.

*Louisiana.*—For the control of the Blanchard quadrangle, in Bossier and Caddo parishes, C. S. Wells and F. W. Crisp ran 86 miles of primary traverse and set 12 permanent marks and also ran 55 miles of primary levels and established 13 permanent bench marks. (See also Mississippi-Louisiana, p. 112.)

*Maine.*—For the continuation of cooperative topographic surveys in Maine the State Water Storage Commission allotted \$4,000, which was met by the United States Geological Survey with an equal amount. The survey of the Liberty quadrangle, in Kennebec, Knox, Lincoln, and Waldo counties, was completed, and that of the Belfast quadrangle, in Knox and Waldo counties, was begun by W. H. Griffin, Duncan Hannegan, K. E. Schlachter, C. H. Davey, and E. W. Bowler, the total area mapped being 151 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Belfast quadrangle Mr. Schlachter ran 15 miles of primary levels and established 3 permanent marks.

In addition to the cooperative work in Maine, the resurvey of the Portland and Casco Bay quadrangles, in Cumberland and York

counties, was completed by Hersey Munroe, R. A. Kiger, and K. F. Maxcy, the area mapped being 163 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

*Mississippi-Louisiana.*—The survey of the Vicksburg quadrangle, in Issaquena and Warren counties, Miss., and Madison Parish, La., was continued by C. E. Cooke, W. H. S. Morey, C. S. Wells, and F. W. Crisp, the area mapped being 245 square miles, for publication on the scale of 1:62,500, with a contour interval of 10 feet. Of this area 8 square miles is in Louisiana. For the control of this area and of the Natchez quadrangle, in Adams and Jefferson counties, Miss., and Concordia Parish, La., H. S. Senseney and R. H. Kilmer ran 116 miles of primary levels and established 34 permanent bench marks.

*New York.*—The State engineer and surveyor of New York allotted \$10,000 for the continuation of cooperative topographic surveys in that State, and the United States Geological Survey allotted an equal amount. The survey of the Canaseraga and Malone quadrangles, in Allegany, Franklin, and Livingston counties, was completed, and that of the Edwards, Hornell, and Moira quadrangles, in Allegany, Franklin, Livingston, Steuben, and St. Lawrence counties, was begun by G. S. Smith, Hersey Munroe, Robert Muldrow, R. C. McKinney, J. M. Whitman, A. P. Meade, jr., T. F. Slaughter, H. L. Dodge, and C. H. Davey, the area mapped being 613 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. In connection with the mapping of these areas and of the Andes, Oswegatchie, Long Eddy, Walton, Sidney, and Oneonta quadrangles, in Delaware, Chenango, Herkimer, Lewis, Otsego, and St. Lawrence counties, A. P. Meade, jr., K. E. Schlachter, H. S. Senseney, A. J. Kavanagh, and F. L. Shalibo ran 422 miles of primary levels and established 114 permanent bench marks. For the control of the Malone, Edwards, and Moira quadrangles G. T. Hawkins ran 117 miles of primary traverse and set 12 permanent marks, and for the control of the Oneonta and Sidney quadrangles, in Chenango, Delaware, and Otsego counties, Mr. Hawkins occupied 6 triangulation stations and marked 4.

In addition to the cooperative work, Mr. Hawkins and F. J. McMaugh occupied 3 triangulation stations in the John Boyd Thatcher Park, in Albany County, and ran 21 miles of primary levels and established 2 permanent bench marks in the Altamont Park, Albany County.

*North Carolina.*—The survey of the Gastonia quadrangle, in Gaston, Lincoln, and Mecklenberg counties, was completed by G. S. Smith, J. M. Whitman, J. H. Le Feaver, and Roscoe Reeves, the area mapped being 82 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet.

*Pennsylvania.*—The Topographic and Geologic Survey Commission of Pennsylvania allotted \$4,000 for the continuation of the cooperative topographic survey of the State, and the United States Geological Survey allotted an equal amount. The survey of the Windber and Windgap quadrangles, in Bedford, Cambria, Carbon, Monroe, Northampton, and Somerset counties, was completed by Robert Muldrow, Oscar Jones, R. A. Kiger, J. B. Metcalfe, jr., E. D. Monroe, and C. E. Mills, the area mapped being 262 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of the Windgap quadrangle and of the Stahlstown quadrangle, in Fayette, Somerset, and Westmoreland counties, C. E. Mills ran 114 miles of primary levels and established 44 permanent bench marks.

In addition to the cooperative work the revision of part of the map of the Houtzdale quadrangle, in Clearfield and Center counties, was commenced by J. I. Gayetty, the area covered being 13 square miles.

*Tennessee-Arkansas.*—For the control of the Memphis quadrangle, in Shelby County, Tenn., and Crittenden County, Ark., F. W. Crisp and Kostka Mudd ran 98 miles of primary traverse and set 8 permanent marks, of which 42 miles and 3 marks were in Arkansas.

*Vermont.*—For the continuation of cooperative topographic surveys in the State of Vermont the governor allotted \$2,000 and the United States Geological Survey allotted an equal amount. The survey of the St. Albans quadrangle, in Franklin and Grand Isle counties, was completed by Duncan Hannegan and J. F. McBeth, the area mapped being 224 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. In connection with this work K. E. Schlachter ran 67 miles of primary levels and established 17 permanent bench marks. The cooperative funds being insufficient to cover the completion of the St. Albans sheet, the additional expenses were borne by the Federal Survey.

*Virginia.*—For the continuation of cooperative topographic surveys in Virginia the State geologist allotted \$4,500 and the United States Geological Survey allotted an equal amount. The resurvey of the Bucu quadrangle and of the Virginia portions of the Hurley and Iaeger quadrangles, in Buchanan, Dickinson, and Russell counties, was completed, and that of the Richlands quadrangle, in Buchanan, Russell, and Tazewell counties, was begun by J. I. Gayetty, C. W. Arnold, F. W. Farnsworth, and Kostka Mudd, the area mapped being 316 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of these areas Mr. Mudd ran 101 miles of primary levels and established 27 permanent bench marks. (See also West Virginia, below.)

*West Virginia.*—In the continuation of cooperative topographic surveys in West Virginia the State geologist expended \$6,758.20 and

the United States Geological Survey \$1,507.49. A resurvey of the West Virginia portions of the Martinsburg, Berryville, and Gerrardstown quadrangles and of the Morgan County portion of the Capon Bridge quadrangle was completed by E. I. Ireland, Hersey Munroe, T. F. Slaughter, K. W. Trimble, and C. W. Arnold, the area mapped being 467 square miles, for publication of the scale of 1 : 62,500, with a contour interval of 20 feet. Of this area 1 square mile is in Virginia. This work completed the mapping of Berkeley, Jefferson, and Morgan counties on the scale of 1 : 62,500. In connection with this work G. T. Hawkins and J. B. Metcalfe, jr., ran 99 miles of primary traverse and set 10 permanent marks, and K. W. Trimble and H. S. Senseney ran 115 miles of primary levels and established 34 permanent bench marks.

For the control of portions of the Webster Springs, Cowen, Richwood, Winona, and Summersville quadrangles Oscar Jones occupied 15 triangulation stations. This work was done to control those portions of Nicholas and Webster counties not yet mapped on the scale of 1 : 62,500.

#### OFFICE WORK.

The drafting of the following sheets was completed: Muscle Shoals and Center Star, Ala.; Talking Rock, Ga.; Casco Bay, Liberty, and Portland, Maine; Canaseraga, N. Y.; Belhaven, Gastonia, and Kinston, N. C.; Windber and Windgap, Pa.; Murfreesboro, Tenn.; St. Albans, Vt.; Bucu, Va.; Iaeger, Va.-W. Va.; Winona, W. Va.

Progress in the drafting of additional sheets was made as follows: Hornell, N. Y., 20 per cent; Malone, N. Y., 50 per cent; Hurley, Va.-Ky., 67 per cent; Berryville, W. Va.-Va., 26 per cent; Capon Bridge, W. Va.-Va., 15 per cent; Gerrardstown, W. Va.-Va., 72 per cent; Martinsburg, W. Va.-Va.-Md., 91 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Center Star (Ala.), Talking Rock (Ga.), Blanchard (La.), Belfast, Liberty, and Portland (Me.), Vicksburg (Miss.), Canaseraga, Edwards, Hornell, and Oswegatchie (N. Y.), Belhaven, Bunyon, and Chocowinity (N. C.), Stahlstown, and Windgap (Pa.), Murfreesboro (Tenn.), Franklin Pond and St. Albans (Vt.), Bucu, Hurley, Iaeger, and Richlands (Va.) quadrangles.

Geographic positions were computed for the Weogufka (Ala.), Blanchard and Bossier (La.), Washington (D. C.-Md.), Natchez and Vicksburg (Miss.), Berne, Edwards, Malone, Moira, Oneonta, Oswegatchie, Sidney, and Stark (N. Y.), Belhaven, Bunyon, and Plymouth (N. C.), Berryville, Gerrardstown, and Martinsburg (W. Va.) quadrangles.

## CENTRAL DIVISION.

## FIELD WORK.

*Summary.*—During the season topographic mapping was carried on in Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The work comprised the completion of the survey of 25 quadrangles and of the resurvey of 7 quadrangles, in addition to which 19 quadrangles were partly surveyed and 3 were partly resurveyed. The total new area mapped was 5,208 square miles, for publication on the scale of 1 : 62,500; and the area resurveyed was 935 square miles, for publication on the scale of 1 : 62,500. In connection with this work 1,971 miles of primary levels were run and 454 permanent bench marks were established.

Primary traverse was carried on at different times by six parties, the work being distributed over portions of Illinois, Iowa, Kentucky, Michigan, Minnesota, and Wisconsin. The total area covered by the primary control was about 4,000 square miles, of which 3,600 square miles was controlled by primary traverse, 958 linear miles of primary traverse being run and 84 permanent marks set. Five triangulation stations were occupied and 4 marked. The result of this work was to make control available in 50 quadrangles.

*Topographic surveys in central division from July 1, 1914, to June 30, 1915.*

State.	Con- tour inter- val.	For publication on scale of 1 : 62,500.		Total area sur- veyed.	Primary levels.		Primary traverse.		Triangulation.	
		New.	Resur- vey.		Dis- tance run.	Bench marks.	Dis- tance run.	Perma- nent marks.	Sta- tions occu- pied.	Stations marked.
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>			
Illinois.....	20	539	.....	539	461	135	373	31	.....	.....
Indiana.....	20	191	.....	191	61	13	.....	.....	.....	.....
Iowa.....	20	119	.....	119	.....	.....	82	13	.....	.....
Kentucky.....	50	.....	913	913	168	47	89	6	5	4
Michigan.....	5, 20	273	.....	273	.....	.....	151	14	.....	.....
Minnesota.....	10	454	.....	454	11	2	12	1	.....	.....
Missouri.....	20	544	22	566	300	86	.....	.....	.....	.....
Ohio.....	10, 20	2,818	.....	2,818	796	129	.....	.....	.....	.....
Wisconsin.....	20	270	.....	270	174	42	251	19	.....	.....
		5,208	935	6,143	1,971	454	958	84	5	4

*Illinois.*—The governor of Illinois allotted \$9,000 for the continuation of cooperative topographic surveys in Illinois and the United States Geological Survey allotted an equal amount. The survey of the Coulterville and Equality quadrangles and of the Illinois portions of the Shawneetown, Birds, Fords Ferry, and Golconda quadrangles in Perry, Randolph, St. Clair, Washington, Gallatin, Hardin, Pope, Saline, Crawford, and Lawrence counties was completed, and that of the Brownfield quadrangle, in Johnson, Massac, and Pope counties,



was begun by C. W. Goodlove, Fred Graff, jr., Gilbert Young, J. A. Duck, R. G. Clinite, R. M. Herrington, and W. S. Gehres, the total area mapped being 539 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Brownfield, Morris, Birds, Good Hope, Paducah, Woodhull, Quincy, Orion, Alexis, Augusta, Monmouth, Meredosia, La Harpe, Mount Sterling, Camp Point, Griggsville, Pittsfield, and Barry quadrangles, in Johnson, Massac, Pope, Grundy, Kendall, Crawford, Lawrence, McDonough, Warren, Henry, Knox, Mercer, Adams, Pike, Rock Island, Brown, Schuyler, Hancock, Cass, Fulton, Henderson, Morgan, Scott, and Greene counties, S. R. Archer, E. C. Bibbee, G. W. Lucas, and R. G. Clinite ran 461 miles of primary levels and established 135 permanent bench marks. For the control of the Augusta, Beardstown, Good Hope, Lomax, Oquaka, Monmouth, Meredosia, La Harpe, Rushville, Kirkland, Wilmington, Sycamore, Shabbona, Quincy, Mount Sterling, Morris, Liberty, Earlville, Dwight, Camp Point, and Yorkville quadrangles, in Adams, Brown, Schuyler, Hancock, Cass, Fulton, McDonough, Warren, Henderson, Pike, Scott, Morgan, Ogle, Dekalb, Boone, Winnebago, Will, Kankakee, Kane, Lee, Grundy, Kendall, La Salle, and Livingston counties, E. L. McNair ran 373 miles of primary traverse and set 31 permanent marks.

*Indiana.*—The mapping of the Indiana portions of the Uniontown and Henderson quadrangles, in Posey and Vanderburg counties, was completed by C. W. Goodlove, W. S. Gehres, and R. M. Herrington, the area mapped being 148 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of these areas S. R. Archer and Marvin Lee ran 61 miles of primary levels and established 13 permanent bench marks. The survey of the Indiana portion of the Birds quadrangle, in Knox and Sullivan counties, was completed by Fred Graff, jr., the area mapped being 30 square miles, for publication on the same scale as the Illinois portion. The mapping of the Indiana portion of the Three Rivers quadrangle was completed by L. L. Lee and H. E. Burney, the area mapped being 13 square miles, for publication on the same scale as the Michigan portion.

*Iowa.*—The State geologist allotted \$1,750 for the continuation of cooperative topographic surveys in Iowa and the Federal Survey allotted an equal amount. The survey of the Boone quadrangle, in Boone, Hamilton, and Webster counties, was completed, and that of the Chariton quadrangle, in Lucas, Marion, and Warren counties, was begun by W. L. Miller, the area mapped being 119 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. For the control of the Chariton quadrangle, and also of the Melrose, Attica, Humeston, New Virginia, and Albia quadrangles,

in Lucas, Marion, Warren, Appanoose, Wayne, Clarke, Monroe, and Mahaska counties, E. L. McNair ran 82 miles of primary traverse and set 13 permanent marks.

*Kentucky.*—The Kentucky Geological Survey allotted \$10,000 for the continuation of cooperative topographic surveys in Kentucky and the United States Geological Survey allotted an equal amount. The resurvey of the Laynesville and Inez quadrangles, in Floyd, Johnson, Lawrence, Martin, and Pike counties, and of the Kentucky portion of the Naugatuck, Hurley, Matewan, and Williamson quadrangles, in Lawrence, Pike, and Martin counties, was completed, and that of the Kentucky portion of the Regina quadrangle, in Pike County, was begun by J. R. Eakin, E. I. Ireland, C. P. McKinley, J. M. Rawls, Howard Clark, S. A. Judson, W. A. Reiter, F. W. Farnsworth, G. W. Lucas, W. S. Gehres, Klett McKinley, and Sylvan Price, the area mapped being 913 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 50 feet. For the control of the Laynesville, Hurley, Matewan, Naugatuck, Regina, and Williamson quadrangles S. R. Archer and Mr. Lucas ran 168 miles of primary levels and established 47 permanent bench marks. For the control of the Kuttawa quadrangle and of the Kentucky portions of the Fords Ferry, Golconda, and Smithland quadrangles, in Crittenden, Livingston, Marshall, Cracken, and Trigg counties, J. H. Wilson ran 89 miles of primary traverse and set 6 permanent marks, and for the control of the Paintsville and Goodloe quadrangles, in Breathitt, Magoffin, Johnson, Morgan, Lawrence, and Floyd counties, C. L. Nelson occupied 5 triangulation stations and marked 4.

*Michigan.*—For the continuation of cooperative topographic surveys in Michigan the State geologist allotted \$2,500 and the United States Geological Survey allotted an equal amount. The survey of the St. Charles quadrangle and of the Michigan portion of the Three Rivers quadrangle, in Midland, Saginaw, and St. Joseph counties, was completed by C. L. Sadler, L. L. Lee, and H. E. Burney, the area mapped being 273 square miles, for publication on the scale of 1 : 62,500, with contour intervals of 5 and 20 feet. For the control of the Perrington, Elsie, Chesaning, and Saginaw quadrangles, in Bay, Clinton, Gratiot, Saginaw, and Shiawassee counties, J. H. Wilson ran 151 miles of primary traverse and set 14 permanent marks.

*Minnesota.*—The State drainage engineer of Minnesota allotted \$4,500 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Aitkin, Pelican Rapids, and Wealthwood quadrangles, in Aitkin, Becker, Clay, and Ottertail counties, was



completed, and that of the Brainerd quadrangle, in Crow Wing County, was begun by F. B. Barrett, J. H. Wilson, E. L. Hain, and L. B. Roberts, the area mapped being 454 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 10 feet. (See also Wisconsin, p. 119.)

*Missouri.*—For the continuation of cooperative topographic surveys in Missouri the State geologist allotted \$5,221.74 and the United States Geological Survey allotted an equal amount. The survey of the Neosho and Eminence quadrangles, in McDonald, Newton, and Shannon counties, was completed by C. G. Anderson, R. L. Harrison, F. W. Hughes, J. M. Rawls, G. W. Lucas, R. H. Randall, W. F. Hicks, and R. M. Herrington, the area mapped being 477 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of these areas and of the Bandyville, Low Wossie, Upalika, Puxico, Grandin, Greenbrier, Hendrickson, Advance, Cape Girardeau, and Morley quadrangles, in Oregon, Shannon, Carter, Ripley, Butler, Wayne, Stoddard, Bollinger, Cape Girardeau, and Scott counties, G. W. Lucas and E. C. Bibbee ran 300 miles of primary levels and established 86 permanent bench marks. The resurvey of the Sturgeon quadrangle, in Audrain, Boone, Howard, and Randolph counties, was completed by C. G. Anderson and W. L. Miller, the area mapped being 22 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

In addition to the cooperative work, the mapping of the Missouri portion of the Kimmswick quadrangle, in Jefferson and St. Louis counties, was completed by F. W. Hughes, R. H. Randall, and W. F. Hicks, the area mapped being 67 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet.

*Ohio.*—For the continuation of cooperative topographic surveys in Ohio the governor allotted \$35,000 and the United States Geological Survey allotted \$10,000. The survey of the Mechanicsburg, Greenfield, Milford Center, Octa, Xenia, Sabina, Morrow, Hillsboro, Sardinia, and Batavia quadrangles and of the Ohio portions of the Lawrenceburg, Richmond, Harrison, Lynn, and Portland quadrangles, in Adams, Brown, Butler, Champaign, Clark, Darke, Highland, Hamilton, Preble, Logan, Madison, Mercer, Union, Fayette, Ross, Clinton, Greene, Warren, and Clermont counties, was completed, and that of the West Union, Piketon, and Bainbridge quadrangles and of the Ohio portions of the Georgetown and Liberty quadrangles, in Adams, Brown, Butler, Preble, Highland, Pike, and Ross counties was begun, the total area mapped being 2,818 square miles for publication on the scale of 1 : 62,500, with contour intervals of 10 and 20 feet. This work was done by J. H. Jennings, A. B. Searle, Gilbert Young, Fred Graff, jr., R. L. Harrison, E. L. Hain, J. A. Duck, J. H. Wilson, F. B. Barrett, M. A. Roudabush, S. L. Parker,

E. C. Burt, R. M. Wilcoxon, Howard Clark, W. A. Reiter, H. E. Burney, W. S. Gehres, and S. A. Judson. For the control of these areas and of the Piketon and Roxabell quadrangles and the Ohio portions of the Bethel, Maysville, Morningview, and Liberty quadrangles, in Pike, Butler, Ross, Brown, Preble, Hamilton and Clermont counties, F. L. Whaley, J. M. Perkins, Mr. Parker, S. R. Archer, and E. C. Bibbee ran 796 miles of permanent levels and established 129 permanent bench marks.

*Wisconsin.*—For the beginning of cooperative topographic surveys in Wisconsin the State geologist allotted \$4,000 and the United States Geological Survey allotted an equal amount. The survey of the Neshkoro and Ripon quadrangles, in Fond du Lac, Green Lake, Marquette, Winnebago, and Waushara counties and of the Wisconsin portion of the Old Superior quadrangle, in Douglas County, was begun by L. L. Lee, L. B. Roberts, and R. M. Herrington, the area mapped being 198 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of these areas E. C. Bibbee and J. M. Perkins ran 173 miles of primary levels and established 44 permanent bench marks, of which 11 miles and 2 marks were in Minnesota. For the control of these areas and of the Fisk, Chaffey, Ripon, Rockmont, Oshkosh, Carlton, Poy Sippi, Montello, Spring Lake, Portage, Cambria, and Fox Lake quadrangles in Fond du Lac, Portage, Columbia, Dodge, Winnebago, Douglas, Green Lake, Marquette, Waushara, Outagamie, and Wau-paca counties, Wis., and Carlton and St. Louis counties, Minn., E. L. McNair ran 263 miles of primary traverse and set 20 permanent marks, of which 12 miles and 1 mark were in Minnesota.

In addition to the cooperative work the survey of the Wilton quadrangle in Monroe County was completed by R. T. Evans, O. H. Nelson, D. H. Watson, and J. M. Perkins, the area mapped being 72 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 20 feet. For the control of this area Mr. Perkins ran 12 miles of primary levels.

#### OFFICE WORK.

The drafting of the following sheets was completed: Birds, Ill.-Ind.; Coulterville and Equality, Ill.; Shawneetown, Ill.-Ky.; Henderson and Uniontown, Ind.-Ky.; Boone, Iowa; Inez, Laynesville, and Virgie, Ky.; St. Charles, Mich.; Three Rivers, Mich.-Ind.; Aitkin, Pelican Rapids, and Wealthwood, Minn.; Kimmswick, Mo.-Ill.; Neosho and Sturgeon, Mo.; Batavia, Greenfield, Mechanicsburg, Milford Center, Morrow, Octa, Sabina, St. Paris, and Xenia, Ohio; Wilton, Wis.

Progress in the drafting of additional sheets was made as follows: Brownfield, Ill.-Ky., 10 per cent; Fords Ferry, Ill.-Ky., 9 per cent; Golconda, Ill.-Ky., 32 per cent; Chariton, Iowa, 25 per cent;

Brainerd, Minn., 30 per cent; Eminence, Mo., 70 per cent; Hillsboro, Ohio, 70 per cent; Sardinia, Ohio, 55 per cent; Old Superior, Wis.-Minn., 35 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Birds, Brownfield, Camp Point, Equality, Good Hope, La Harpe, Lomax, Meredosia, Morris, Paducah, Pittsfield, Quincy, Shawneetown, and Sparta (Ill.), Alzey and Evansville (Ind.), Hurley, Inez, Laynesville, and Matewan (Ky.), Advance, Eminence, Neosho, Salem, and Sinkin (Mo.), Bainbridge, Batavia, Bethel, Hillsboro, Lawrenceburg, Morrow, Piketon, Portland, Richmond, Roxabell, and Sabina (Ohio), Old Superior and Wilton (Wis.) quadrangles.

Geographic positions were computed for the Augusta, Beardstown, Camp Point, Good Hope, La Harpe, Liberty, Lomax, Meredosia, Monmouth, Morris, Mount Sterling, Oquawka, Quincy, Rushville, and Shabbona (Ill.), Attica and Chariton (Iowa), Chesaning, Elsie, and Perrinton (Mich.), Eminence, Knobnoster, Neosho, Odessa, and Warrensburg (Mo.), Cambria, Fisk, Fox Lake, Montello, Neshkoro, Old Superior, Oshkosh, Portage, Poy Sippi, Ripon, and Spring Lake (Wis.) quadrangles.

#### ROCKY MOUNTAIN DIVISION.

##### FIELD WORK.

*Summary.*—During the season topographic mapping was carried on in Colorado, Montana, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming, and in a small area in Minnesota. This work comprised the completion of the survey of 10 quadrangles and 1 special area and the resurvey of 2 quadrangles and 1 special area, in addition to which 10 quadrangles and 2 special areas were partly surveyed and 1 special area was partly resurveyed. The total new area mapped was 3,855 square miles, 3,247 square miles for publication on the scale of 1 : 125,000, 429 square miles for publication on the scale of 1 : 62,500, 149 square miles for publication on scale of 1 : 31,680, and 30 square miles for publication on the scale of 1 : 12,000. The total area resurveyed was 526 square miles, 484 square miles for publication on the scale of 1 : 62,500, and 42 square miles for publication on the scale of 1 : 24,000. In addition the map of 1 quadrangle was revised and that of 1 quadrangle was partly revised, the area covered being 1,215 square miles. In connection with this work 2,179 miles of primary levels were run and 592 permanent bench marks were established.

Primary traverse and primary triangulation were carried on at different times by 7 parties, the work extending over portions of Colorado, New Mexico, Oklahoma, Texas, and Wyoming. The total area covered by this primary control was about 15,400 square miles,

of which 1,440 square miles was controlled by primary traverse, 662 miles being run and 196 permanent marks set. Ninety triangulation stations were occupied and 56 marked. This work made control available in 60 quadrangles.

*Topographic surveys in Rocky Mountain division from July 1, 1914, to June 30, 1915.*

State.	Contour interval.	For publication on scale of—					
		1:125,000.	1:62,500.		1:31,680.	1:24,000.	1:12,000.
		New.	New.	Re-survey.	New.	Re-survey.	New.
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>
Colorado.....	5, 100	1, 338	.....	.....	101	.....	.....
Montana.....	20, 100	389	50	.....	.....	.....	.....
New Mexico.....	25, 50, 100	1, 238	.....	.....	.....	42	.....
Oklahoma.....	25	.....	83	484	.....	.....	.....
Texas.....	2, 5, 25	.....	21	.....	48	.....	30
Wyoming.....	25, 50	282	275	.....	.....	.....	.....
		3, 247	429	484	149	42	30

State.	Total area surveyed.	Primary levels.		Primary traverse.		Triangulation.	
		Distance run.	Bench marks.	Distance run.	Perma- nent marks.	Stations occupied.	Stations marked.
	<i>Sq. mi.</i>	<i>Miles.</i>		<i>Miles.</i>			
Colorado.....	1, 439	552	152	.....	.....	58	35
Montana.....	439	.....	.....	.....	.....	.....	.....
Nebraska.....	.....	13	2	.....	.....	.....	.....
New Mexico.....	1, 280	689	180	.....	.....	10	8
Oklahoma.....	567	160	48	94	13	.....	.....
South Dakota.....	.....	3	2	.....	.....	.....	.....
Texas.....	99	588	175	568	183	18	12
Wyoming.....	557	142	25	.....	.....	1	.....
Arizona.....	.....	23	6	.....	.....	.....	.....
Minnesota.....	.....	9	2	.....	.....	.....	.....
	4, 381	2, 179	592	662	196	87	55

*Arizona.*—(See New Mexico, p. 123.)

*Colorado.*—The mapping of the Craig quadrangle, in Moffat County, and the San Luis Lake special area, in Alamosa County, was completed, and that of the Naturita quadrangle, in Montrose and San Miguel counties, was begun by C. L. Nelson, C. W. Rowell, J. H. Wilke, C. T. Moore, R. W. Berry, E. P. Davis, Basil Duke, and R. R. Monbeck, the area mapped being 736 square miles, 635 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 101 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas and of the Coventry and Montrose quadrangles, in Montrose, San Miguel, Ouray, Gunnison, and Hinsdale counties, J. R. Ellis, Mr. Monbeck, R. W. Burchard, Mr. Rowell, and Mr. Moore ran 487 miles of primary levels and established 131 permanent bench marks, and for the control of the Naturita quadrangle C. F. Urquhart occupied

8 triangulation stations and permanently marked 9. The survey of the Creede quadrangle, lying partly in the San Juan, Cochetopa, and Rio Grande national forests, in Mineral, Rio Grande, and Saguache counties, was completed, and that of the Del Norte and Home quadrangles, lying partly in the Rio Grande, Cochetopa, Arapahoe, and Colorado national forests, in Alamosa, Jackson, Larimer, Rio Grande, and Saguache counties, was begun by Mr. Duke, C. A. Ecklund, R. C. Seitz, Cornelius Schnurr, and C. C. Holder, the area mapped being 703 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 324 square miles is in the national forests. For the control of the Home quadrangle Mr. Ecklund and Roscoe Reeves ran 65 miles of primary levels and established 21 permanent bench marks. For the control of the Del Norte, Glenwood Springs, Kremmling, Home, Pagoda, Rabbit Ears Peak, Eagle, Leadville, Leon Peak, Mount Powell, Snow Mass Mountain, Gateway, Delta, Livermore, Grand Junction, Pinon Valley, Cameo, and De Beque quadrangles, Colorado, and the Sherman quadrangle, Wyoming, lying partly in the Leadville, Holy Cross, Sopris, Arapahoe, Colorado, Routt, White River, Gunnison, and Battlement national forests, in Eagle, Garfield, Rio Blanco, Routt, Grande, Jackson, Delta, Mesa, Moffat, Lake, Peak, Larimer, Summit, Chaffee, Pitkin, and Gunnison counties, Colo., and Albany and Laramie counties, Wyo., C. F. Urquhart, C. B. Kendall, and Mr. Ellis occupied 51 triangulation stations (1 in Wyoming) and marked 26.

The roads in the Mesa Verde National Park were located on the administrative map of the park by C. L. Nelson for the Department of the Interior, all the expenses of the work being borne by the Department.

*Minnesota.*—(See South Dakota, North Dakota, and Minnesota, p. 124.)

*Montana.*—The survey of the unmapped portion of the Nashua quadrangle, in Dawson and Valley counties, was completed, and that of the unmapped portion of the Nameless quadrangle, in Valley County, was begun by R. C. Seitz, the area mapped being 50 square miles, for publication on the scale of 1:62,500, with a contour interval of 20 feet. The portions of these quadrangles lying in the Fort Peck Indian Reservation were mapped by the General Land Office. The survey of the unmapped portion of the Heart Butte quadrangle, lying partly in the Lewis and Clark National Forest, in Flathead and Teton counties, was completed by R. T. Evans, O. H. Nelson, and D. H. Watson, the area mapped being 389 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet, 153 square miles being in the national forest. The remainder of this quadrangle, lying in the Blackfeet Indian Reservation, was mapped by the General Land Office. (See also Idaho-Montana, p. 127.)



*Nebraska.*—For the control of the Stella and Falls City quadrangles in Richardson County, S. H. Birdseye ran 13 miles of primary levels and established 2 permanent bench marks.

*New Mexico.*—The mapping of the Tularosa and Tres Hermanos quadrangles, in Dona Ana, Otero, Socorro, and Lincoln counties, was completed, and that of the Reserve quadrangle, lying partly in the Socorro National Forest, in Socorro County, was begun by R. C. Seitz, C. C. Gardner, S. T. Penick, C. C. Holder, and D. H. Watson, the total area mapped being 1,238 square miles, for publication on the scale of 1:125,000, with contour intervals of 50 and 100 feet. Of this area 462 square miles was in the national forest. For the control of these areas and of the Koehler, Soudders, Magdalena, Leura Springs, Datil, Mogollon, and Nutrioso quadrangles, in Sierra, Colfax, and Socorro counties, N. Mex., and Apache and Greenlee counties, Ariz., Mr. Holder and R. W. Burchard ran 712 miles of primary levels and established 186 permanent bench marks, of which 23 miles and 6 marks were in Arizona. For the control of the Koehler quadrangle Mr. Ellis occupied 10 triangulation stations and permanently marked 8. The resurvey of the Tyrone special area, in Grant County, was completed, and that of the Mogollon special area, in Socorro County, was begun by B. A. Jenkins and R. W. Berry, the area mapped being 42 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. The map of the Deming quadrangle, in Luna County, was revised by E. P. Davis, the area covered by this revision being 1,009 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. (See also Arizona, p. 131.)

*North Dakota.*—(See South Dakota, North Dakota, and Minnesota, p. 124.)

*Oklahoma.*—The director of the Oklahoma Geological Survey allotted \$1,000 for the continuation of cooperative topographic surveys in that State and the United States Geological Survey allotted an equal amount. The survey of the Foraker quadrangle, in Osage County, was completed by S. T. Penick and R. R. Monbeck, the area mapped being 83 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The resurvey of the Kiefer and Bristow quadrangles, in Creek, Tulsa, and Okmulgee counties, was completed by R. T. Evans, Mr. Penick, C. C. Gardner, R. H. Reineck, Mr. Monbeck, A. O. Burkland, D. H. Watson, and C. R. Fisher, the area mapped being 484 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of these areas Mr. Fisher and Mr. Monbeck ran 160 miles of primary levels and established 48 permanent bench marks, and C. B. Kendall and Mr. Fisher ran 94 miles of primary traverse and set 13 permanent marks. The cooperative funds being insufficient to cover the

completion of the mapping of these areas, the additional expenses were borne by the Federal Survey.

In addition to the cooperative work the revision of the map of the Hominy quadrangle, in Osage, Pawnee, Tulsa, and Creek counties, was completed by R. W. Berry, the total area covered by this revision being 206 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet.

*South Dakota, North Dakota, and Minnesota.*—For the control of the White Rock quadrangle, in Roberts County, S. Dak., Richland County, N. Dak., and Traverse County, Minn., A. J. Kavanagh ran 12 miles of primary levels and established 4 permanent bench marks, of which 9 miles and 2 marks were in Minnesota and 3 miles and 2 marks in South Dakota.

*Texas.*—For the cooperative topographic survey of Harris County the county allotted \$35,000 and the United States Geological Survey allotted \$5,000. The mapping of the Erin, Deepwater, and Rice 7½-minute quadrangles was begun by C. H. Birdseye, B. A. Jenkins, W. B. Lewis, E. R. Bartlett, O. H. Nelson, J. H. Wilke, T. P. Pendleton, and F. A. Danforth, the area mapped being 48 square miles, for publication on the scale of 1 : 31,680, with a contour interval of 5 feet. For the control of these quadrangles and of the Settegast, Vollner, Hillendahl, Missouri City, Pearland, Strang, Almeda, Clodine, Barker, Katy, Swanson, Cypress, Ashford, Hockley, Rose Hill, Waller, Number Two, Louetta, Spring, Humble, Aldine, Kliber, Pauli, Huffman, Crosby, Hermaston, Fauna, and Stuebner quadrangles, E. L. McNair and W. F. Hicks ran 470 miles of primary traverse and set 147 permanent marks, and R. R. Monbeck ran 281 miles of primary levels and established 89 permanent bench marks.

In addition to the cooperative work, the mapping of the Henrietta quadrangle, in Clay, Archer, and Wichita counties, was begun by C. A. Ecklund and A. O. Burkland, the total area mapped being 21 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of this area and of the Walter quadrangle, in Clay and Wichita counties, Roscoe Reeves ran 141 miles of primary levels and established 38 permanent bench marks, and for the control of these areas and of the Archer City and Eschite quadrangles, in Archer, Wichita, and Wilbarger counties, J. R. Ellis and Mr. Ecklund occupied 18 triangulation stations and marked 12. The mapping of the Sabine and Trinity River projects, in Wood, Smith, Dallas, Ellis, and Kaufman counties was commenced by C. H. Birdseye, B. A. Jenkins, W. B. Lewis, E. R. Bartlett, and R. R. Monbeck, the area mapped being 30 square miles, for publication on the scale of 1 : 12,000, with a contour interval of 2 feet. For the control of these areas E. L. McNair, Mr. Birdseye, and Mr. Monbeck ran 166 miles of primary levels and established 48 permanent bench marks,



and Mr. McNair ran 98 miles of primary traverse and set 36 permanent marks.

*Wyoming.*—The mapping of the Blue Mesa and Saddleback Hills quadrangles, in Carbon, Hot Springs, and Washakie counties, was completed by R. H. Reineck, C. C. Gardner, S. T. Penick, and C. R. Fisher, the total area mapped being 275 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The mapping of the Moorcroft quadrangle, in Crook and Weston counties, was begun by Messrs. Gardner, Reineck, and Fisher, the area mapped being 282 square miles, for publication on the scale of 1:125,000, with a contour interval of 50 feet. For the control of these areas Mr. Fisher and G. R. Ruby ran 142 miles of primary levels and established 25 permanent marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Craig, Creede, and San Luis Lake, Colo.; Heart Butte and Nashua, Mont.; Deming (revision), N. Mex.; Tres Hermanos, Tularosa, and Tyrone special, N. Mex.; Bristow, Foraker, and Kiefer, Okla.; Claremore and Hominy (revision), Okla.; Mission, Sabine River, San Juan, and Trinity River, Tex.; Blue Mesa and Saddleback Hills, Wyo.

Progress in the drafting of additional sheets was made as follows: Del Norte, Colo., 18 per cent; Home, Colo., 7 per cent; Naturita, Colo., 22 per cent; Nameless, Mont., 83 per cent; Moorcroft, Wyo., 8 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Nutrioso (Ariz.-N. Mex.), Coventry, Del Norte, Home, Hooper, La Jara, Lay, Montrose, Naturita, Saguache, and Silesia (Colo.), Dodson and Hays (Mont.), Datil, Tres Hermanos, Koehler, Luera Springs, Magdalena, Ojo Caliente, Patterson, Reserve, Shiprock, Soudders, Pineville, and Tularosa (N. Mex.), Blue Butte and Elbowoods (N. Dak.), Nuyaka (Okla.), Archer City, Eschite, Henrietta, Walter, Almeda, Deepwater, Erin, Missouri City, Pearland, Rice and Strang, and the Wills Point and Mineola (Sabine River project) and Dallas and Kaufman (Trinity River project) (Tex.), Thermopolis and Widdowfield (Wyo.) quadrangles.

Geographic positions were computed for the Del Norte, Grand Junction, Eagle, Glenwood Springs, Kremmling, Leadville, Leon Peak, Naturita, Meeker, Mount Jackson, Mount Powell, Pagoda, Rabbit Ears Peak, DeBeque, Delta, Gateway, Palisades, Rifle, and Snow Mass Mountain (Colo.), Koehler (N. Mex.), Bristow and Kiefer (Okla.), Almeda, Archer City, Eschite, Henrietta, Bonham, Dallas (Trinity River project), Wills Point (Sabine River project), Almeda, Deepwater, Erin, Missouri City, Paris, Pearland, Petrolia, Rice,

Strang, Webster, Barker, Clodine, Cypress, Hillendahl, Katy, Missouri City, Swanson, Vollner, Aldine, Ashford, Hockley, Louetta, Rose Hill, Spring, and Waller (Harris County) (Tex.) quadrangles.

NORTHWESTERN DIVISION.

FIELD WORK.

*Summary.*—During the season topographic mapping was carried on in Idaho, Oregon, and Washington and in a small area in Montana. This work comprised the completion of the survey of 10 quadrangles and the partial survey of 10 quadrangles. The total new area mapped was 4,008 square miles; 2,974 square miles for publication on the scale of 1 : 125,000; 870 square miles for publication on the scale of 1 : 62,500; and 164 square miles for publication on the scale of 1 : 31,680. In connection with this work 747 miles of primary levels were run and 202 permanent bench marks were established. In addition, profile surveys were made of portions of 5 rivers, the distance traversed being 262 linear miles for publication on the scale of 1 : 31,680.

Primary triangulation and primary traverse were carried on at different times by five parties in portions of Idaho, Montana, Oregon, and Washington. The total area covered by this primary control was about 7,200 square miles, of which about 575 square miles was controlled by primary traverse, 149 miles being run and 40 permanent marks set. Sixty-five triangulation stations were occupied and 58 permanently marked. This work made control available in 23 quadrangles.

*Topographic surveys in northwestern division from July 1, 1914, to June 30, 1915.*

State.	Con- tour inter- val.	For publication on scale of—			To- tal area sur- vey- ed.	Primary levels.		Primary traverse.		Triangula- tion.	
		1 : 125,000	1 : 62,500	1 : 31,680		Dis- tance run.	Bench marks.	Dis- tance run.	Per- ma- nent marks.	Sta- tions occu- pied.	Sta- tions mark- ed.
Idaho.....	<i>Feet.</i> 50, 100	<i>Sq. mi.</i> 334	<i>Sq. mi.</i> 351	<i>Sq. mi.</i> 2	<i>Sq. mi.</i> 687	<i>Miles.</i> 178	35	<i>Miles.</i> .....	.....	62	58
Oregon.....	<i>5, 25,</i> <i>{ 50, 100 }</i>	1, 305	304	162	1, 771	357	112	79	20	.....	.....
Washington	25, 50	1, 217	215	.....	1, 432	212	55	70	20	.....	.....
Montana....	100	118	.....	.....	118	.....	.....	.....	.....	3	.....
		2, 974	870	164	4, 008	747	202	149	40	65	58

*Idaho.*—The mapping of the Henry and Portneuf quadrangles, in Bannock County, was completed, and that of the Mink Creek quad-  
rangle, lying partly in the Cache National Forest, in Bannock, Bear  
Lake, and Franklin counties, was begun by Albert Pike, J. L. Lewis,  
and C. G. Anderson, the area mapped being 563 square miles, 351

square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet, and 212 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 80 square miles was in the national forest. For the control of these areas and of the Soda Springs quadrangle, in Bannock and Bear Lake counties, F. L. Whaley ran 178 miles of primary levels and established 35 permanent bench marks. For the control of these areas, and of the Malad City and Sterrett quadrangles, and the south half of the Ammon quadrangle, in Bannock, Bingham, and Oneida counties, H. H. Hodgeson and T. M. Bannon occupied 22 and marked 21 triangulation stations. A profile survey of Snake River was commenced by C. G. Anderson, the distance traversed being 48 linear miles in Madison County. In connection with this work 2 square miles covering a power site were surveyed.

*Idaho-Montana.*—The mapping of the Avery quadrangle, lying partly in the Lolo, Cabinet, St. Joe, and Cœur d'Alene national forests, in Shoshone County, Idaho, and Mineral and Sanders counties, Mont., was completed, and that of the St. Regis quadrangle, lying partly in the St. Joe, Lolo, and Cabinet national forests, in the same counties, was begun by J. E. Blackburn, the total area mapped being 240 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 178 square miles is in the national forests and 118 square miles in Montana. In connection with the mapping of the Avery quadrangle 5 square miles of the map of the Cœur d'Alene National Forest was revised. For the control of the Salmon, Noble, Gibbons Pass, Vinegar Hill, Casto, Rabbit Foot, May, Custer, Bay Horse, Mackay, and Hailey quadrangles, lying partly in the Bitterroot, Selway, Beaverhead, Salmon, Lemhi, Idaho, Sawtooth, Nez Perce, and Challis national forests, in Lemhi and Custer counties, Idaho, and Ravalli and Beaverhead counties, Mont., T. M. Bannon occupied 43 triangulation stations (3 in Montana) and marked 37.

*Oregon.*—For the continuation of cooperative topographic surveys in Oregon the State engineer allotted \$18,000 and the United States Geological Survey allotted an equal amount. In the survey of the Willamette Valley the mapping of the Salem, Corvallis, Lebanon, and Brownsville quadrangles, in Benton, Marion, Linn, and Polk counties, was continued, and that of the Dallas quadrangle, in Polk County, was begun by Charles Hartmann, Olinus Smith, J. H. Le Feaver, R. B. Kilgore, and D. S. Birkett, the total area mapped being 162 square miles for publication on the scale of 1:31,680, with a contour interval of 5 feet. For the control of these areas Mr. Birkett and E. M. Bandli ran 82 miles of primary levels and established 27 permanent bench marks. The mapping of the Tualatin and Condon quadrangles, in Clackamas, Washington, Jefferson, Yamhill, Gilliam, Morrow, Sher-

man, and Wheeler counties, was completed, and that of the Hillsboro quadrangle, in Columbia, Multnomah, and Washington counties, was begun by C. H. Birdseye, Albert Pike, C. L. Sadler, Fred Graff, jr., S. G. Lundey, O. H. Nelson, and J. H. Le Feaver, the total area mapped being 959 square miles, 655 square miles for publication on the scale of 1:125,000, with a contour interval of 50 feet, and 304 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Condon and Hillsboro quadrangles and also of the Twickenham and Heisler quadrangles, in Crook, Jefferson, Wheeler, and Wasco counties, E. M. Bandli ran 134 miles of primary levels and established 45 permanent bench marks, and for the control of the Hillsboro quadrangle L. F. Biggs ran 79 miles of primary traverse and set 20 permanent marks. Profile surveys of portions of Willamette, Umpqua, and White rivers were made by Albert Pike and C. P. McKinley, the distance traversed being 172 linear miles in Douglas, Lane, and Wasco counties. Of this distance 60 miles lies in the Cascade and Umpqua national forests.

In addition to the cooperative work in Oregon, the mapping of the Diamond Lake quadrangle in the Crater, Cascade, Paulina, and Umpqua national forests, in Douglas, Klamath, Jackson, and Lane counties, was completed, and that of the Kerby quadrangle, lying partly in the Siskiyou National Forest, in Curry and Josephine counties, was begun by J. G. Staack, A. O. Burkland, R. B. Kilgore, R. M. Wilson, and John McCombs, the total area mapped being 650 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 600 square miles is in the national forests. For the control of this area and of the Diamond Peak, Disston, Wendling, and Eugene quadrangles, lying partly in the Cascade, Paulina, Santiam, and Umpqua national forests, in Douglas, Lane, Klamath, and Linn counties, R. M. Wilson ran 141 miles of primary levels and established 40 permanent bench marks. A profile survey of the portion of North Umpqua River in the Diamond Lake quadrangle was made by Mr. Kilgore, the distance traversed being 42 linear miles, for publication on the scale of 1:48,000, with contour intervals of 5 and 25 feet.

*Washington.*—For the continuation of cooperative topographic surveys in Washington the State Board of Geological Survey allotted \$11,500 and the United States Geological Survey allotted an equal amount. The mapping of the Coyote Rapids, Priest Rapids, and Pasco quadrangles, in Benton, Grant, Kittitas, Yakima, Franklin, and Walla Walla counties, was completed by H. L. McDonald and S. G. Lunde, the total area mapped being 816 square miles, 215 square miles for publication on the scale of 1 : 62,500, with a contour interval of 25 feet, and 601 square miles for publication on the scale

of 1 : 125,000, with a contour interval of 50 feet. The mapping of the Chehalis quadrangle, lying partly in the Rainier National Forest, in Lewis, Pierce, and Thurston counties, was completed, and that of the Prosser quadrangle, in Benton, Klickitat, and Yakima counties, was begun by W. O. Tufts, H. L. McDonald, N. E. Ballmer, L. V. Fees, John McCombs, and A. L. Wilson, the area mapped being 616 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 50 feet. Of this area  $1\frac{1}{2}$  square miles is in the national forest. For the control of the Chehalis quadrangle L. F. Biggs ran 7 miles of primary traverse and set 3 permanent marks. For the control of the Prosser quadrangle and also of the Wallula quadrangle, in Benton, Franklin, and Walla Walla counties, D. S. Birkett ran 123 miles of primary levels and established 36 permanent bench marks.

In addition to the cooperative work, for the control of the Mount St. Helens and Eatonville quadrangles, lying partly in the Columbia and Rainier national forests, in Clarke, Cowlitz, Lewis, Pierce, Skamania, and Thurston counties, Mr. Biggs and C. P. McKinley ran 63 miles of primary traverse and set 17 permanent marks, and for the control of the Mount St. Helens quadrangle and also of the Kalama quadrangle, in Cowlitz County, Mr. Biggs ran 89 miles of primary levels and established 19 permanent bench marks.

#### OFFICE WORK.

The drafting of the following sheets was completed: Henry and Portneuf, Idaho; Avery, Idaho-Mont.; Condon, Diamond Lake, North Umpqua River, Tualatin, Umpqua River, White River, and Willamette River, Oreg.; Chehalis, Coyote Rapids, Pasco, and Priest Rapids, Wash.

Progress in the drafting of additional sheets was made as follows: St. Regis, Idaho-Mont., 33 per cent; Brownsville, Oreg., 15 per cent; Corvallis, Oreg., 30 per cent; Dallas, Oreg., 17 per cent; Lebanon, Oreg., 37 per cent; Salem, Oreg., 45 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Bruneau, Portneuf, Henry, Lanes Creek, Mink Creek, Mountain Home, Riddle, and Tindall (Idaho); Brownsville, Condon, Corvallis, Diamond Lake, Diamond Peak, Disston, Heisler, Hillsboro, Lebanon, and Twickenham (Oreg.); Kalama, Mount St. Helens, and St. Helens (Wash.) quadrangles.

Geographic positions were computed for the Bay Horse, Casto, Custer, Dickey, May, Nicholia, Noble, Rabbit Foot, and Vinegar Hill (Idaho); Junction, Polaris, Noble, and Salmon (Idaho-Mont.); Hillsboro (Oreg.); and Kalama and Mount St. Helens (Wash.) quadrangles.

PACIFIC DIVISION.

FIELD WORK.

*Summary.*—During the season topographic mapping was carried on in Arizona, California, Nevada, and Utah. This work comprised the completion of the survey of 19 quadrangles and the resurvey of 4 quadrangles and 1 special area, in addition to which 4 quadrangles were partly surveyed. The map of a partial quadrangle was revised to bring it up to date with the new work, the area covered by this revision being 210 square miles. The total new area mapped was 5,161 square miles, 3,641 square miles for publication on the scale of 1 : 125,000, 995 square miles for publication on the scale of 1 : 62, 500, and 525 square miles for publication on the scale of 1 : 31,680. The area resurveyed was 504 square miles, 167 square miles for publication on the scale of 1 : 125,000, 299 square miles for publication on the scale of 1 : 62,500, and 38 square miles for publication on the scale of 1 : 24,000. In connection with this work 787 miles of primary and precise levels were run and 167 permanent bench marks were established. In addition, profile surveys were made of 7 rivers, the distance traversed being 236 linear miles.

Primary triangulation was carried on at different times by four parties, the work being distributed over portions of California and Nevada. The total area covered by this primary control was about 3,600 square miles, 71 triangulation stations being occupied and 37 marked. The result of this work was to make control available in 44 quadrangles.

Topographic surveys were made in the Territory of Hawaii, covering portions of one island (Hawaii). The survey of one 15-minute quadrangle was completed, the area mapped being 19 square miles, for publication on the scale of 1 : 31,680, with a contour interval of 10 feet.

Topographic surveys in Pacific division from July 1, 1914, to June 30, 1915.

State.	Contour interval.	For publication on scale of—						Total area surveyed.	Primary and precise levels.		Triangulation.	
		1:125,000		1:62,500		1:31,680	1:24,000		Distance run.	Bench marks.	Stations occupied.	Stations marked.
		New	Re-survey.	New	Re-survey.	New	Re-survey.					
	<i>Feet.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Sq. mi.</i>	<i>Miles.</i>			
Arizona.....	25,100	642	.....	290	.....	.....	.....	932	165	32	.....	.....
California....	5, 25, 100	2,362	.....	705	69	525	.....	3,661	429	86	63	32
Nevada.....	5	53	.....	.....	.....	.....	38	84	150	39	8	5
Utah.....	50, 100	507	167	.....	230	.....	.....	911	43	10	.....	.....
New Mexico..	100	77	.....	.....	.....	.....	.....	77	.....	.....	.....	.....
Hawaii.....	10	3,641	167	995	299	525	38	5,665	787	167	71	37
		.....	.....	.....	.....	19	.....	.....	.....	.....	.....	.....



*Arizona.*—The survey of the Gila Butte and Christmas quadrangles, in Maricopa, Gila, and Pinal counties, was completed by T. P. Pendleton and C. A. Stonesifer, the total area mapped being 290 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. In connection with the mapping of the Gila Butte quadrangle, the map of the area previously surveyed was revised, the total area covered by this revision being 210 square miles, for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of the Christmas and Ray quadrangles, in Gila and Pinal counties, S. H. Birdseye ran 50 miles of primary levels and established 10 permanent bench marks. The mapping of the San Simon quadrangle, lying partly in the Chiricahua National Forest, in Cochise, Graham, and Greenlee counties, Ariz., and Grant County, N. Mex., was completed by F. A. Danforth and Cornelius Schnurr, the area mapped being 719 square miles, for publication on the scale of 1 : 125,000, with a contour interval of 100 feet. Of this area 61 square miles is in the national forest and 77 square miles in New Mexico. For the control of this area and of the Duncan, Solomonsville, San Carlos, Bisbee, and Pearce quadrangles, lying partly in the Apache, Chiricahua, Crook, and Gila national forests, in Gila, Cochise, Graham, Greenlee, and Pinal counties, Ariz., and Grant County, N. Mex., Mr. Birdseye ran 115 miles of primary levels and established 22 permanent bench marks, all this work being in Arizona. (See also New Mexico, p. 123.)

*California.*—For the continuation of cooperative topographic surveys in California the department of engineering allotted \$14,000 and the United States Geological Survey allotted an equal amount. In continuation of the survey of the San Joaquin Valley the mapping of the Denair, Cressy, Ceres, Crows Landing, Mitchell School, Winton, Merced, Hopeton, and Turlock 7½-minute quadrangles and of the Copperopolis 15-minute quadrangle, in Calaveras, Merced, Stanislaus, and Tuolumne counties, was completed by A. O. Burkland, H. W. Peabody, A. J. Ogle, J. B. Leavitt, S. H. Birdseye, F. A. Danforth, and C. A. Stonesifer, the total area mapped being 683 square miles, 525 square miles for publication on the scale of 1 : 31,680, with a contour interval of 5 feet, and 158 square miles for publication on the scale of 1 : 62,500, with a contour interval of 25 feet. For the control of the Crows Landing, Mitchell School, Turlock, Stevinson, No. VII, No. VIII, No. IX, No. X, Deadman Creek, Kearney Peak, Le Grand, Jesbel, Clovis, Chowchilla Slough, Minturn, Berendo, Fresno, Friant, Herndon, Planada, Plainsberg, Sharon, Madera, Bridge, No. XV, No. XVI, No. XVII, No. XIX, No. XX, No. XXI, Merced, Newman, Ingomar, Owens Creek, Las Garzas Creek, San Luis Creek, Mariposa Slough, Salt Slough, Gustine, Volta, Los Banos, Elgin, Center School, and Daulton 7½-minute quadrangles



and the Indian Gulch 15-minute quadrangle, in Madera, Fresno, Merced, Stanislaus, Mariposa, and San Joaquin counties, C. L. Nelson, C. F. Urquhart, and L. F. Biggs occupied 63 triangulation stations and marked 32, and for the control of the Copperopolis, Trigo, Bachelor Valley, No. VII, No. IX, No. X, Deadman Creek, Owens Creek, Indian Gulch, Le Grand, Madera, Berendo, Sharon, Planada, Plainsberg, La Grange, Daulton, Snelling, and Merced Falls quadrangles, in the same counties, Roscoe Reeves and D. S. Birkett ran 141 miles of primary levels and established 37 permanent bench marks.

In addition to the funds for regular cooperative surveys in California, \$2,500 was allotted by the University of California for the survey of the Santa Rosa quadrangle, in Napa and Sonoma counties, and the United States Geological Survey allotted an equal amount. The funds from the university were made available in the spring of 1914, as stated in the previous report, when field work was commenced. During the year the survey of the Santa Rosa quadrangle was completed by J. P. Harrison, B. A. Jenkins, and A. J. Ogle, the area mapped being 159 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet.

The city of Los Angeles allotted \$2,500 for the cooperative topographic survey of the Elizabeth Lake quadrangle, lying partly in the Santa Barbara National Forest, in Los Angeles and Kern counties, and the United States Geological Survey allotted an equal amount. The mapping of this quadrangle was completed by D. L. Reaburn, C. P. McKinley, N. E. Ballmer, Roscoe Reeves, and J. W. Muller, the total area mapped being 981 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 221 square miles is in the national forest. The services of Mr. Reaburn were provided by the city of Los Angeles, by which his salary and expenses were paid. In connection with the mapping of this quadrangle Mr. Ballmer mapped 44 square miles in the Kramer quadrangle, which lies directly east of the Elizabeth Lake area.

In addition to the cooperative work the survey of the Seiad and Sawyers Bar quadrangles, lying partly in the Klamath, Siskiyou, and Trinity national forests, in Humboldt, Siskiyou, and Trinity counties, was completed, and that of the Preston quadrangle, in the Klamath and Siskiyou national forests, in Del Norte and Siskiyou counties, was begun by J. P. Harrison, J. W. Muller, and W. R. Chenoweth, the area mapped being 744 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. This entire area is within the national forests. In connection with the mapping of these quadrangles profile surveys of portions of Klamath, Scott, and Salmon rivers were made by Messrs. Harrison, Muller, and Chenoweth, the distance traversed being 149 linear miles, for publication on the

the scale of 1:48,000, with contour intervals of 5 and 25 feet. For the control of the Preston quadrangle Mr. Biggs ran 72 miles of primary levels and established 20 permanent bench marks. The resurvey of the Mare Island quadrangle was completed by Mr. Leavitt, the area mapped being 69 square miles, for publication on the scale of 1:62,500, with a contour interval of 25 feet. The survey of the Pajaro and Morgan Hills quadrangles, in San Benito, Santa Clara, Santa Cruz, and Monterey counties, was begun, and that of the Cholame quadrangle, in Fresno, Kern, Kings, Monterey, and San Luis Obispo counties was continued by E. P. Davis, J. E. Blackburn, A. T. Fowler, H. W. Peabody, A. J. Ogle, Olinus Smith, J. H. Le Feaver, N. E. Ballmer, and J. B. Leavitt, the total area mapped being 742 square miles, 354 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 388 square miles for publication on the scale of 1:62,500, with a contour interval of 25 feet. For the control of the Bridgeport, Mount Lyell, Mount Morrison, and Bishop quadrangles, in Mono, Fresno, and Inyo counties, T. P. Pendleton and D. S. Birkett ran 73 miles of primary levels and established 20 permanent bench marks. L. F. Biggs completed a precise level line across the Tehachapi Pass from Bakersfield to San Pedro, 143 miles being run and 9 permanent bench marks established in order to check elevations previously established so as to determine possible earth movement.

*California-Nevada.*—The mapping of the White Mountain quadrangle, lying partly in the Inyo and Mono national forests, in Mono County, Cal., and Mineral and Esmeralda counties, Nev., was completed, the area mapped being 292 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 136 square miles is in the national forests, 239 square miles in California, and 53 square miles in Nevada.

*Nevada.*—The resurvey of the Manhattan mining district, in Nye County, was completed by A. T. Fowler, the area mapped being 38 square miles, for publication on the scale of 1:24,000, with a contour interval of 25 feet. For the control of this area Mr. Fowler occupied 8 triangulation stations and marked 5. For the control of the Pioche district, in Lincoln County, and of the Carson Sink and Wadsworth quadrangles, in Churchill County, D. S. Birkett and T. P. Pendleton ran 151 miles of primary levels and established 39 permanent bench marks, of which 7 miles and 1 mark were in the Utah portion of the Pioche quadrangle.

*Utah.*—The survey of the Logan quadrangle, lying partly in the Cache National Forest, in Cache, Boxelder, and Rich counties, was completed by H. H. Hodgeson, the area mapped being 507 square miles, for publication on the scale of 1:125,000, with a contour interval of 100 feet. Of this area 187 square miles is in the national

forest. In connection with the mapping of the Logan quadrangle profile surveys of Logan and Blacksmith Fork rivers were made by Mr. Hodgeson, the distance traversed being 37 linear miles, for publication on the scale of 1:48,000, with a contour interval of 25 feet. The resurvey of the Vernal, Wellington, and Castle Gate quadrangles, in Uinta and Carbon counties, was completed by E. R. Bartlett and Cornelius Schnurr, the total area mapped being 397 square miles—167 square miles for publication on the scale of 1:125,000, with a contour interval of 100 feet, and 230 square miles for publication on the scale of 1:62,500, with a contour interval of 50 feet. For the control of the Castle Gate quadrangle Mr. Schnurr ran 42 miles of primary levels and established 10 permanent bench marks. (See also Nevada, p. 133.)

*Hawaii.*—To complete the cooperative topographic work begun under the agreement for the fiscal year 1914 the Territory of Hawaii allotted \$837.35 and the United States Geological Survey allotted \$305. The survey of the island of Hawaii was continued, the area mapped being 19 square miles, for publication on the scale of 1:31,680, with a contour interval of 10 feet. This work, which was done by A. T. Fowler, completed the mapping of the Hilo 15-minute quadrangle.

#### OFFICE WORK.

The drafting of the following sheets was completed: Gila Butte, Pearce, and San Simon, Ariz.; Ceres, Copperopolis, Cressy, Crows Landing, Denair, Riverbank, Klamath River, Mare Island, Merced, Mitchell School, Hopeton, Salmon River, Santa Rosa, Sawyers Bar, Scott River, Seiad, Stanislaus River, Turlock, Waterford, and Winton, Cal.; San Francisco and vicinity (revision), Cal.; Manhattan mining district and Yerington mining district, Nev.; Blacksmith Fork River, Castle Gate, Duchesne River, Green River, Logan, Logan River, Uinta River, Vernal, Wellington, and White River, Utah.

Progress in the mapping of additional sheets was made as follows: White Mountain, Cal.-Nev., 70 per cent; Hilo, Hawaii, 74 per cent.

The following computations and adjustments were made:

Primary-level circuits were adjusted for the Christmas, Maricopa, and Pearce quadrangles (Ariz.), the Nutrioso and San Simon quadrangles (Ariz.-N. Mex.), the Bridgeport, Copperopolis, Elizabeth Lake, Mount Lyell, and Mount Morrison quadrangles, and the San Joaquin Valley (Cal.), the Aura, Carson Sink, Delamar, Elko, Kumiva, Panaca, Pyramid, Reno, and Wadsworth quadrangles (Nev.), and the Castle Gate (Utah) quadrangle.

Precise leveling was adjusted for new lines from Kern via Mohave to Orange and from Florence to San Pedro, Cal., and for old lines from Benicia to Kern and from Barstow to Mohave, Cal.

Geographic positions were computed for the Santa Rosa (Cal.), Hilo (Hawaii), Vernal (Utah) quadrangles and for the Mitchell School, Turlock, Cressy, Winton, Hopeton, Stevinson, No. VIII, Atwater, Merced, Planada, Mariposa Slough, and Owens Creek (Cal.) 7½-minute quadrangles.

#### SECTION OF FIELD EQUIPMENT.

During the year 1914 a section of field equipment was organized for the custody of all field equipment of the three field branches of the Survey. The personnel of the section consists of E. M. Douglas, two clerks, and one laborer.

During the year this section received and recorded all incoming field instruments and supplies, and packed and shipped all outgoing instruments. The custody of topographic notebooks and field records was assigned to the section, as well as the general supervision of instrument repair work in the Survey instrument shop. With the exception of extensive repairs to such instruments as aneroid barometers, leveling rods, cameras, and microscopes, for which the Survey shop is not at present fitted, the shop, under the immediate charge of Ernest Kübel with one assistant, made repairs or alterations to more than 2,000 different articles, including 205 standard telescopic alidades, 53 Gale alidades, 62 Y levels, 12 transits, 11 theodolites, 175 box compasses, 119 Brunton and other compasses, 50 tally registers, and 133 sight alidades. The instrument shop also made, resurfaced, or electrotyped over 140,000 square inches of plates.

#### INSPECTION OF TOPOGRAPHIC SURVEYING AND MAPPING.

J. H. Renshawe spent two months in inspecting field work in the Atlantic division. W. M. Beaman visited topographic parties in the central, Rocky Mountain, and northwestern divisions and made frequent field inspections of the work on the large-scale map of Washington, D. C., and vicinity. A. M. Walker inspected field parties in the Atlantic and central divisions. Mr. Beaman spent one month and Mr. Walker two months in field work on the Washington and vicinity map.

The office duties of Messrs. Beaman and Walker included supervision of the inking of all topographic field sheets and office preparation of river-profile and land-classification sheets and reports and final examination of them prior to photolithography, engraving, and proper transmission; also attention to the referred matter of a technical nature pertaining to the branch as a whole rather than to any particular topographic division. Mr. Beaman's office duties also included special attention to river-profile surveys, the supervision of the map of Washington and vicinity, and cooperation with M. R.

Campbell in the preparation of a set of 50 topographic sheets illustrating physiographic and engineering features for the use of schools and in the selection and description of an exhibit of topographic sheets for the Panama-Pacific Exposition at San Francisco.

Mr. Renshawe's entire office time was spent in preparing colored relief maps of national parks and in similar work, as reported in detail on page 107.

#### MILLIONTH-SCALE MAP OF THE UNITED STATES.

Of the work in progress last year on the 1 : 1,000,000 scale map of the United States, under the direction of A. F. Hassan, the base map of Oregon (portions of sheets K-10, K-11, L-10, and L-11) was completed, as was the contouring of sheet K-18. New work included the adjustment of 35 per cent of the township lines and 20 per cent of the compilation and inking of the base map of Idaho (portions of sheets K-11, K-12, L-11, L-12, and M-11), the completion of the base map of the Navajo country, Arizona, and New Mexico (portions of sheets I-12, I-13, J-12 and J-13), and the compilation and inking of the contours for 60 per cent of sheet J-18, 80 per cent of sheet J-17, 15 per cent of sheet J-16, 40 per cent of sheet J-15, 25 per cent of sheet I-17, 40 per cent of sheet I-16, 20 per cent of sheet I-15, and 65 per cent of the United States portion of sheet K-17. Roads were compiled and inked for 30 per cent of sheet J-17, for 75 per cent of sheet J-18, and for 25 per cent of sheet K-18.

Three tracings and 21 maps were also prepared for the Bureau of Fisheries, all the expenses of the work being borne by that bureau.

Tracings of six sheets of an enlargement of the map of San Luis Valley, Colorado, were also prepared for the Reclamation Service.

#### WATER-RESOURCES BRANCH.

##### ORGANIZATION AND SCOPE OF WORK.

The water-resources branch includes three divisions—surface water, ground water, and water utilization—each of which is subdivided into sections for field work. The organization is as follows:

Chief of branch, N. C. Grover, chief hydraulic engineer.

Division of surface waters, John C. Hoyt, hydraulic engineer, in charge.

Division of ground waters, O. E. Meinzer, geologist, in charge.

Division of water utilization, N. C. Grover, chief hydraulic engineer, in charge.

##### PERSONNEL.

During the year the technical force of the water-resources branch has been reduced 10 by transfers, resignations, and deaths and has been increased 9 by new appointments. At the end of the year the force consisted of 1 chief hydraulic engineer, 12 hydraulic engineers, 28 assistant engineers, 25 junior engineers, 1 hydrographer, 1 geol-

ogist, 1 associate geologist, 3 assistant geologists, 1 geologic aid, 1 chemist, 1 assistant chemist, and 1 junior chemist, a total of 76. Of this number, 1 hydraulic engineer, 3 assistant engineers, 1 assistant chemist, and 3 junior engineers are on furlough; and 1 hydraulic engineer, 1 hydrographer, 3 assistant engineers, and 1 assistant geologist are employed occasionally.

In the clerical force there were 2 separations and 3 accessions. At the end of the year the force consisted of 2 senior clerks, 1 clerk, 9 junior clerks, 9 under clerks, 1 copyist, 1 stenographer, 1 clerk-stenographer, 1 draftsman, and 1 messenger boy.

#### ALLOTMENTS.

The appropriation was the same as in the preceding year (\$150,000). The cooperative funds made available by State allotments have been increased in some States and decreased in others, making necessary corresponding adjustments of the work.

The appropriation for the fiscal year was allotted as follows:

*Allotments of appropriation for investigation of water resources, 1914-15.*

Administrative expenses of the Survey.....	\$10,344
Branch administration.....	8,250
Computations and reports.....	17,000
Inspection.....	1,500
Stream gaging in—	
New York and New England States.....	\$5,650
Virginia and Maryland.....	600
South Atlantic and Gulf States.....	5,500
Ohio Valley.....	6,000
Upper Mississippi Valley States.....	5,000
Colorado and Wyoming.....	6,500
Montana.....	4,500
North Dakota.....	300
Utah.....	4,500
Nevada.....	2,500
Idaho.....	4,500
Oregon.....	4,500
Washington.....	4,500
California.....	4,500
New Mexico.....	4,500
Arizona.....	3,000
Hawaii.....	5,000
Yellowstone National Park.....	200
	<hr/> 71,750
Investigation of ground waters, including quality of waters.....	17,500
Land-classification board.....	11,000
Water-power investigations.....	11,000
Contingent.....	1,656
	<hr/> 150,000

Of the total appropriation, 64 per cent was allotted for work in public-land States.



COOPERATION.

*States.*—Cooperative funds were allotted by several States as follows:

*Amounts allotted by States for cooperative work with United States Geological Survey in investigation of water resources.*

Alabama .....	\$170
Arizona.....	3, 900
California—	
State engineer.....	\$6, 700
Conservation commission.....	1, 300
City of San Diego.....	1, 000
City of San Francisco.....	4, 200
	————— 13, 200
Colorado.....	480
Connecticut.....	1, 000
Hawaii.....	15, 400
Idaho.....	1, 900
Illinois .....	3, 400
Iowa.....	450
Kentucky .....	670
Maine .....	75
Massachusetts.....	3, 350
Minnesota.....	2, 100
Montana.....	2, 500
Nevada.....	1, 800
New Mexico.....	7, 200
New York—	
State engineer .....	\$1, 400
Conservation commission.....	10, 500
	————— 11, 900
North Dakota.....	350
Oregon.....	11, 000
South Dakota.....	960
Utah.....	4, 100
Vermont.....	900
Washington.....	5, 950
West Virginia.....	400
Wisconsin.....	8, 800
Wyoming.....	1, 600
	————— 103, 555

The work done under cooperative agreements in the several States has been limited to stream gaging, except as indicated below.

In addition to a large amount of stream gaging in California, investigations of ground water were made in San Diego County and in Sacramento and Santa Clara valleys, and measurements of depths to the ground-water level were made in southern California.

In Connecticut the cooperative work consisted chiefly of ground-water surveys.

In Hawaii, besides stream gaging, measurements of precipitation and studies of water losses in irrigation canals were made.

A compilation of stream-flow records in Oregon is now in press.

A detailed study of the water supply and the present and possible future use of Sevier River, Utah, begun in 1914, was still in progress at the end of the fiscal year.

In addition to the cooperative work tabulated above, in which the States have furnished part of the money for examinations made by the Survey staff, investigations of ground waters in cooperation with the agricultural experiment stations of New Mexico and Arizona were continued as in previous years, the experiment stations making analyses of samples of water and soluble salts collected.

*Reclamation Service.*—Cooperation with the Reclamation Service in stream gaging has been continued. The gaging stations operated at the expense of the reclamation fund are on streams that are to furnish water to reclamation projects under construction by that Service. The field work of stream gaging is done by Survey engineers who are engaged in such work in the locality, and repayment of actual cost is made by the Reclamation Service through a transfer of funds.

*Office of Indian Affairs.*—Investigations and reports have been made at the request of the Commissioner of Indian Affairs in connection with the classification of lands within Indian reservations with regard to water-power and reservoir sites and for the purpose of locating ground-water supplies, as follows:

The investigation of the occurrence and availability of ground water in the Hopi and Navajo reservations was completed during the year, and a report was prepared for publication.

A report was made on the possibility of developing water power on Hogback Canal, in T. 12 N., Rs. 1 and 2 W., and T. 13 N., R. 2 W., New Mexico meridian, in the Navajo Reservation.

An investigation was made to determine the practicability of developing ground-water supplies for irrigation on the San Carlos Reservation.

A report was made on the power-site and reservoir possibilities on the Wind River Reservation.

Stream gaging was continued on the following Indian reservations, in accordance with authorizations of the Office of Indian Affairs: Colville, Crow, Fort Hall, Klamath, La Pointe, Menominee, Pine Ridge, Queniult, Rosebud, San Carlos, Standing Rock, Warm Springs, and Yakima.

*Public Health Service.*—Special stream-gaging work in cooperation with the Public Health Service in connection with an investigation of the pollution of Ohio River, begun in the previous year, was completed.

*United States Engineer Office.*—Stream gaging in connection with navigation and flood studies in the Ohio basin is in progress in cooperation with the United States Engineer Office.

*City of San Francisco.*—Stream gaging is in progress on Tuolumne River, in cooperation with the city of San Francisco, in connection

with the utilization of the water of that river, to be stored in the Hetch Hetchy Valley as a water supply for the city.

#### PUBLICATIONS.

The publications prepared by the water-resources branch comprised 33 water-supply papers and 18 separate chapters. Titles and brief summaries of these publications are given on pages 27-35. At the close of the year 24 other reports were in press and 6 manuscripts were in hand awaiting editing.

#### GENERAL SUMMARY.

In the investigation of surface waters the water-resources branch has maintained 1,350 gaging stations for measuring the discharge of streams in 41 States and Hawaii. It is, however, only through extensive cooperation with States and other Federal organizations that the relatively large amount of work now in progress can be carried on. Twenty-six cooperating States (including Hawaii) have contributed more than \$100,000 for work in those States, and the Reclamation Service, Indian Office, Army Engineers, and Public Health Service have also cooperated, largely in the study of the flow of particular rivers. The cooperating States include many Northern and Eastern States and all the States in the Rocky Mountain, Great Basin, and Pacific groups where water is necessary for agriculture by irrigation. At the close of the year gaging stations were being maintained at 1,350 points, including 129 in Hawaii. In addition, records were received from about 250 stations maintained by private enterprises. The resulting records of river discharge are published in an annual progress report consisting of 14 water-supply papers and in special water-supply papers.

Investigations of ground water have been made in 12 States, but the lack of funds prevents the comprehensive study of the occurrence, quantity, and quality that is commensurate with the importance of such water. This work should be greatly extended, especially in those sections of the arid States where further agricultural development can be made only by use of ground water. Several water-supply papers are published yearly containing the results of ground-water investigations.

Many investigations of the present and probable future use of both surface and ground waters have been made in connection with the classification of the public lands, with special reference to their use for power under permit or for agriculture under the enlarged-homestead, desert-land, or Carey acts. The results of such investigations appear generally in unpublished special reports to the Commissioner of the General Land Office and to the Secretary of the Interior.

G. K. Gilbert, geologist, who has worked under the joint auspices of the geologic and water-resources branches, revised and enlarged his report on the "Hydraulic mining debris of the Sierra Nevada, California." The field work necessary for this revision consisted of two series of current observations—one series made in the Golden Gate opposite Fort Point, for the purpose of ascertaining certain tidal constants which affect the estimates of movements of mining debris delivered by the rivers to the San Francisco Bay system, and one series made in a slough near Ravenswood, Cal., for the purpose of determining the quantity of tidewater received and delivered by marshlands. Mr. Gilbert received important aid in these observations from the Lighthouse Service, the United States Army engineers, and the United States Coast and Geodetic Survey.

#### DIVISION OF SURFACE WATERS.

##### ORGANIZATION.

The work of the division of surface waters consists primarily of the measurement of the flow of rivers, but includes also special investigations of conditions affecting stream flow and utilization of the streams. In carrying on the work the United States is divided into 16 districts, including Hawaii. Two of these districts were established during the year—New England, which was formed by dividing the North Atlantic district, and Arizona, which was formed by dividing the Arizona and New Mexico district. The New Mexico district was discontinued on June 30, 1915, and the work consolidated with that of the Rocky Mountain district. The following list gives the districts, names of the district engineers, and location of offices:

New England: C. H. Pierce, Customhouse, Boston, Mass.

New York: C. C. Covert, Federal Building, Albany, N. Y.

Middle Atlantic: G. C. Stevens, Washington, D. C.

South Atlantic and eastern Gulf: Warren E. Hall, Federal Building, Atlanta, Ga.

Ohio Valley: A. H. Horton, Federal Building, Newport, Ky.<sup>1</sup>

Upper Mississippi River: W. G. Hoyt, Capitol Building, Madison, Wis.; suboffice, Old Capitol Building, St. Paul, Minn.

Upper Missouri: W. A. Lamb, Montana National Bank Building, Helena, Mont.

Rocky Mountain: Robert Follansbee, Chamber of Commerce Building, Denver, Colo.

Great Basin: E. A. Porter, Federal Building, Salt Lake City, Utah.

Idaho: G. C. Baldwin, Idaho Building, Boise, Idaho.

Oregon: Fred F. Henshaw, Couch Building, Portland, Oreg.

Washington: G. L. Parker, Federal Building, Tacoma, Wash.

California: H. D. McGlashan, Customhouse, San Francisco, Cal.; suboffice, Federal Building, Los Angeles, Cal.

Arizona: C. C. Jacob, 417 Fleming Building, Phoenix, Ariz.

New Mexico: G. A. Gray, Capital City Bank Building, Santa Fe, N. Mex.

Hawaii: G. K. Larrison, Kapiolani Building, Honolulu.

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<sup>1</sup> Office temporarily closed during the year; work conducted from Washington office.

## CHARACTER AND METHODS OF WORK.

Field investigations incident to the work are made from the district offices, where the results are sufficiently analyzed to insure their accuracy and completeness. At selected places, known as gaging stations, measurements of discharge are made and other data are collected from which the daily flow of the streams is computed. At the end of the year 1,350 gaging stations were maintained. During the year 408 stations were discontinued and 412 stations established. In addition, records ready for publication were received for about 250 stations from other Government bureaus and private persons. During the year 8,040 measurements of discharge were made. Many of the stations are maintained in cooperation with other Federal bureaus, State organizations, or private persons.

The following table shows the distribution of the stations and measurements by States and the number of stations maintained by cooperating parties:

*Report of gaging stations and cooperating parties for the year ending June 30, 1915.*

Results of field data collected from the district offices are transmitted to the Washington office, where they are reviewed in the computing section and prepared for publication. This review insures accuracy in the data and brings the results from different parts of the country to a uniform standard. Regular field inspections are made and annual conferences of the engineers are held, whereby the work in the several districts is standardized.

PUBLICATIONS.

For convenience and uniformity in publication the United States has been divided into 12 primary drainage basins, as shown in the following table, and the results of stream measurements are published annually in a series of progress reports that correspond to these 12 divisions. Prior to 1914 the records for each division were contained in a single water-supply paper; beginning with 1914 the reports for the twelfth division will be published as three separate papers.

In 1913 a seasonal or climatic year—October 1 to September 30—was adopted for the presentation of reports on regions west of the Rocky Mountains and on upper Mississippi and Ohio rivers; in 1914 the use of the climatic year was extended to all districts.

*Numbers of water-supply papers containing results of stream measurements, 1910–1914.*

Part—	Area.	1910	1911	1912	1913	1914
I	North Atlantic.....	281	301	321	351	381
II	South Atlantic and eastern Gulf of Mexico.....	282	302	322	352	382
III	Ohio River.....	283	303	323	353	383
IV	St. Lawrence River and Great Lakes.....	284	304	324	354	384
V	Hudson Bay and upper Mississippi River.....	285	305	325	355	385
VI	Missouri River.....	286	306	326	356	386
VII	Lower Mississippi River.....	287	307	327	357	387
VIII	Western Gulf of Mexico.....	288	308	328	358	388
IX	Colorado River.....	289	309	329	359	389
X	Great Basin.....	290, 291	310	330	360	390
XI	California.....	291	311	331	361	391
XII	North Pacific.....	292	312	332	362	.....
	Pacific basins in Washington and upper Columbia River.....			332-A	362-A	392
	Snake River basin.....			332-B	362-B	393
	Lower Columbia River and Pacific basins in Oregon.....			332-C	362-C	394

In addition to the regular progress reports, special reports on various hydraulic subjects have been completed for publication during the year, as is indicated in the list on pages 27–35.

DIVISION OF GROUND WATERS.

SCOPE OF WORK.

The main function of the division of ground waters is to make a survey of the underground waters of the country with reference to their utilization. The investigations of each year form part of a comprehensive plan that includes the entire country. Because of



the great interest throughout the West in irrigation with ground water and the prospects for considerable developments of this kind, most of the work has been done in the arid and semiarid States and with special reference to irrigation.

The chemical investigations, which are under the supervision of R. B. Dole, cover both surface and ground waters. Progress was made in the preparation of a comprehensive report on the chemical composition of the surface waters of the United States by Mr. Dole, assisted by E. C. Bain, C. D. Parker, and A. A. Chambers. The chapter on the production of mineral waters for the annual volume *Mineral Resources of the United States*, with a history of the mineral-water trade of the United States since 1883, was prepared by Mr. Dole. Maps and manuscripts for geologic folios were reviewed so far as they related to ground water.

Nearly 40 investigations of ground water or quality of water (including the reports in press) were in progress, covering areas in Arizona, Arkansas, California, Connecticut, Florida, Georgia, Idaho, Maine, Mississippi, Montana, Nevada, New Mexico, Oregon, Texas, and Washington. The work in Arkansas, Florida, Georgia, Mississippi, and Texas was done in cooperation with the section of Coastal Plain investigations of the geologic branch, and the work in Idaho was done by the division of water utilization. During the year 11 reports were completed and 10 were published.

#### WORK BY STATES.

*Arizona.*—A comprehensive report on the ground water of the Hopi and Navajo Indian reservations, in Arizona and adjacent parts of New Mexico and Utah, was completed by H. E. Gregory, who has been in charge of the investigation since its beginning in 1909. The report will be published as Water-Supply Paper 380. The ground-water conditions of an area west of Little Colorado River have also been investigated by Prof. Gregory, and a report covering the area is in preparation. Both investigations were made in cooperation with the Office of Indian Affairs.

By direction of the Secretary of the Interior, an investigation of the ground water in Paradise Valley, with special reference to its utilization for irrigation, was made by O. E. Meinzer and A. J. Ellis. A report on this investigation was completed and sent to press to be published as Water-Supply Paper 375-B. Analyses of water from this valley were made by the Arizona Agricultural Experiment Station.

An investigation of the ground water in the San Carlos Reservation with respect to its availability for irrigation was undertaken for the Office of Indian Affairs by A. T. Schwennesen, who completed the field work and is now preparing a report.

A short time was spent by Mr. Schwennesen in the San Simon Valley for the purpose of obtaining data on the yield and pressure of artesian wells in that valley. The San Simon investigation was begun in 1913 and was resumed in the summer of 1915. The water analyses are made by the Arizona Agricultural Experiment Station, through the cooperation of R. H. Forbes, director.

*Arkansas.*—The report on the geology and underground-water resources of eastern and northeastern Arkansas, by L. W. Stephenson and A. F. Crider, with a discussion of the chemical character of the waters by R. B. Dole, was completed by the authors before the beginning of the fiscal year and is being prepared for the printer. It is to be published as a water-supply paper.

*California.*—A comprehensive report on the springs of California, by G. A. Waring, was published as Water-Supply Paper 338. It is based on extensive field work done by Mr. Waring in earlier years.

The field work for the ground-water survey of the Sacramento Valley, which was begun in September, 1912, was continued by Kirk Bryan, assisted by J. W. Muller, and was completed about January 1, 1915. A preliminary report by Mr. Bryan on ground water for irrigation in the Sacramento Valley was published as Water-Supply Paper 375-A, and considerable work was done on the maps and manuscript for the final report on the region.

Good progress was made during the year by W. O. Clark in the ground-water survey of the Santa Clara Valley, on which he has been engaged since August, 1912. A report on the ground-water resources of the Niles cone, which is a part of the Santa Clara Valley, was prepared by Mr. Clark and was published as Water-Supply Paper 345-H.

The final report on ground water in the San Joaquin Valley, by W. C. Mendenhall, R. B. Dole, and Herman Stabler, was completed and sent to the printer to be published as Water-Supply Paper 398. Some work was also done by W. C. Mendenhall and G. A. Waring on the San Jacinto Valley investigation.

An investigation of the ground-water resources of the part of San Diego County lying west of the divide was undertaken by A. J. Ellis and C. H. Lee, and most of the field work and considerable of the office work was completed. The results are to be embodied in a comprehensive report on the water resources of the county. The analytical work was done by S. C. Dinsmore. Financial cooperation was furnished by the city of San Diego.

Since 1900 measurements of depths of the water level in a series of wells in southern California have been made at intervals for the purpose of obtaining a record through many years of the relations between the contributions to the underground reservoirs in the rainy

seasons and the withdrawals from them in the dry seasons, when ground water is pumped for irrigation and when evaporation and transpiration are most rapid. Most of the records for the period prior to 1909 have been published in Water-Supply Papers 213 and 251; the records for 1909, 1910, and 1912, together with a brief discussion by W. C. Mendenhall, were published during the year in Water-Supply Paper 331. The work is at present being carried on by F. C. Ebert, who has selected companion wells and otherwise improved the methods. Mr. Ebert has also made progress in the tabulation of all available water-level data for the region.

All the ground-water work in California is supported by financial cooperation of the State Department of Engineering.

*Connecticut.*—The report on ground water in the Hartford, Stamford, Salisbury, Willimantic, and Saybrook areas, by H. E. Gregory and A. J. Ellis, which was completed before the beginning of this fiscal year, is now in press as Water-Supply Paper 374.

The report on ground water in the Waterbury area, by A. J. Ellis, was completed during the year and was sent to the printer to be published as Water-Supply Paper 397.

An investigation of the relations between precipitation, ground-water storage, evaporation, and run-off in the Pomeraug Valley, begun in July, 1913, by A. J. Ellis, was continued, observations being made regularly during the year and the data tabulated and plotted.

A ground-water survey of the Meriden area was made by G. A. Waring, and 25 samples of water were collected for mineral analysis.

A ground-water survey of the Plainville area was made by H. S. Palmer, and at the close of the year work was in progress in other towns in the northeastern section of the State.

All the work in Connecticut is done in cooperation with the State Geological and Natural History Survey, W. N. Rice, superintendent, and is under the supervision of H. E. Gregory. The results of the various surveys will be published in water-supply papers.

*Florida.*—Some progress was made during the year on the investigation of the quality of ground waters in Florida, and work on this project is to be resumed by Mr. Dole in the near future. Daily samples of sea water from Fowey Rocks Light were tested for chlorine content in connection with Mr. Vaughan's study of oceanographic phenomena on the Florida coast.

*Georgia.*—The report on the ground waters of the Coastal Plain of Georgia, by L. W. Stephenson and J. O. Veatch, with a discussion of the chemical character of the waters by Mr. Dole, was published as Water-Supply Paper 341. The investigation on which this report is based was conducted in cooperation with the Georgia Geological Survey.

*Idaho.*—An investigation of the ground water in the Fort Hall Indian Reservation was made by W. B. Heroy, and a report prepared by him was incorporated in a general paper on the geology and resources of the region which is to be published as a bulletin.

At the request of the division of drainage investigations, Department of Agriculture, an examination of water-level problems on irrigated lands in the vicinity of Twin Falls was made by Mr. Heroy, and a manuscript report by him on the causes and cure of the rising water levels was transmitted to the Department of Agriculture.

*Maine.*—At the request of the Secretary of the Navy, a brief examination of available water supplies in the vicinity of the Portsmouth Navy Yard was made by O. E. Meinzer.

*Mississippi.*—The division of ground water continued its cooperation with the section of Coastal Plain investigations of the geologic branch in the general investigation of ground water in Mississippi. (See pp. 50–51.) The analytical work was supervised by Mr. Dole.

*Montana.*—The report on the water resources of Butte, Mont., by O. E. Meinzer, was published as Water-Supply Paper 345-G.

Through the cooperation of the division of surface waters and A. W. Mahon, State engineer of Montana, steps were taken near the close of the year to collect the records of the most important wells in the State.

*Nevada.*—The report on ground water in southeastern Nevada by Everett Carpenter was published as Water-Supply Paper 365.

Additional field work was done by O. E. Meinzer in Big Smoky Valley, chiefly on the contributions of the streams to the underground supply. A preliminary report on this valley was prepared and sent to the printer to be published as Water-Supply Paper 375-D. The final report on the geology and water resources of Big Smoky, Clayton, and Alkali Spring valleys was completed by Mr. Meinzer. The chemical work was done by S. C. Dinsmore.

Near the close of the year an investigation of water levels on the Truckee-Carson project was undertaken for the Department of Justice by C. H. Lee and W. O. Clark.

*New Mexico.*—The report on the Tularosa Basin and adjacent areas, by O. E. Meinzer and R. F. Hare, prepared in cooperation between the New Mexico Agricultural Experiment Station and the Survey, was published as Water-Supply Paper 343.

Work on the ground-water resources of southern Grant County, including the Animas, Playas, and Hachita valleys, was continued by A. T. Schwennesen, of the Survey, and Mr. Hare, of the experiment station, and at the close of the fiscal year the report was nearly completed.

The report on ground water in the Hopi and Navajo reservations, by H. E. Gregory, covers a part of northwestern New Mexico. (See Arizona, p. 144.)

A number of samples of water collected by Mr. Schwennesen in Luna County were analyzed by Mr. Hare at the experiment station.

*Oregon.*—The report on the quality of surface waters of Oregon, by Walton Van Winkle, prepared in cooperation with J. H. Lewis, State engineer of Oregon, was published as Water-Supply Paper 363.

*Texas.*—The work in Texas was done in cooperation with the section of Coastal Plain investigations, geologic branch, and was confined to the Coastal Plain.

The report on the geology and underground waters of the southeastern part of the Texas Coastal Plain, by Alexander Deussen, was published as Water-Supply Paper 335.

A report on the ground-water supply of Lasalle and McMullen counties, by Alexander Deussen and R. B. Dole, was completed and is to be published as Water-Supply Paper 375-G.

Work was continued on the ground-water resources of the part of the Texas Coastal Plain not covered by Water-Supply Paper 335, and two papers are being prepared.

*Washington.*—The report on the quality of the surface waters of Washington, prepared by Walton Van Winkle in cooperation with the State board of health, was published as Water-Supply Paper 339.

#### DIVISION OF WATER UTILIZATION.

The organization of the division of water utilization has been continued during the year, as described in previous annual reports. E. C. La Rue and E. C. Murphy, hydraulic engineers, have done the greater part of the field work involved in the examination of water-power withdrawals, rights of way, and Carey Act segregations. The work of examining land for designation under the enlarged-homestead act has been done in part by Messrs. La Rue and Murphy and in part by W. B. Heroy, geologist, and W. N. White, assistant classifier, in the land-classification board, who were detailed to the work during a portion of the field season. In addition to routine field work, Mr. La Rue has devoted about six months to the preparation of a manuscript relative to the present and probable future utilization of Colorado River for irrigation, power, and navigation. The report is practically complete and will be published as Water-Supply Paper 395. Mr. Murphy has made a field examination of the possibilities of water-power and reservoir development in Arizona and in the Gila drainage basin in New Mexico in order that lands valuable for such purposes may be designated in accordance with the act of Congress admitting Arizona and New Mexico to statehood. Reports based on these examinations were completed late in the year.



**LAND-CLASSIFICATION BOARD.****ORGANIZATION.**

Since the land-classification board became a separate branch, on May 1, 1912, its organization and its functions have remained practically stable. The work of the board consists of the receipt from the field branches of the results of investigations made for or adaptable to public-land classification and the transformation of those results into actual classifications, which become the basis of that part of the Department of the Interior's administration of the public-land laws that depends on the character of the lands.

The geologic branch, for example, examines the coal lands of the public domain. The results of the field examination are prepared in accordance with regulations and suggestions formulated by the board and are transmitted to it for use in making reports on the character of the lands or in preparing withdrawals, restorations, or valuations, as may be required. The geologic branch also studies the oil fields of the public domain and likewise reports the results, and after a careful consideration of these results by the land-classification board, the Director transmits to the Secretary of the Interior appropriate recommendations for the creation of petroleum reserves or for their cancellation, or takes any other appropriate action that will assist in the administration of the public-land laws applying to oil.

The topographic branch furnishes a share of the field data that form the basis of classification, not merely by the preparation of general topographic maps and the accompanying classification plats, which permit a study of drainage areas and irrigation possibilities, but by special profile surveys of streams that appear to have power value. These surveys enable the board to make close classification of lands according to their power value, and are valuable in the administration of the laws that control water-power development.

The water-resources branch, by its general work in the gaging of streams, is constantly assembling data essential to the classification of lands both as to power value and as to irrigability. Its groundwater division ascertains facts that are used in the classification required by the enlarged-homestead acts, and its division of water utilization makes examinations that furnish the groundwork necessary for the public-land classifications required by the laws which provide for the disposal of lands through the use of water.

The classifications required by our public-land laws fall into two broad groups—a group dependent on the presence or absence of mineral deposits in the land and a group dependent on the presence or absence of water. The board, in its organization, following this natural grouping of its problems, is composed of two divisions, a division of mineral classification and a division of hydrographic



classification. Sections are organized within each division to deal with each of the major subjects with which the division deals. The organization in outline is as follows:

- W. C. Mendenhall, chief.
- Elsie Patterson, secretary.
- Division of mineral classification: Coal section, G. H. Ashley, chairman; E. R. Lloyd, vice chairman. Oil section, M. W. Ball, chairman. Phosphate section, A. R. Schultz, chairman. Metalliferous section, A. R. Schultz, chairman.
- Division of hydrographic classification: Section of utilization, Herman Stabler, chairman. Section of classification, W. B. Heroy, chairman.

The staff of the board during the year, although it has varied because of temporary assignments made from time to time, has averaged about 37 persons, of whom 8 are geologists, 8 engineers, 3 draftsmen, 16 clerks of various grades, and 2 messengers. Several changes in the personnel have resulted from assignments of members of the board staff to other branches of the Survey and of assignments to the board to fill vacancies thus created or to take up work not heretofore adequately provided for.

FUNDS.

One of the primary functions of the Geological Survey specifically mentioned in "the organic act" approved March 3, 1879, is the classification of the public lands. Each of the three field branches of the organization, the geologic, the topographic, and the water resources, spends a part of its appropriation in field examinations whose results are submitted to the board for use in official land classification. Specific allotments for the board's office work are made by the Director from the general appropriations. These allotments for the fiscal year 1915 amounted to \$58,000 and were distributed among the general appropriations as follows:

Geologic surveys.....	\$31,500
Topographic surveys.....	11,500
Gaging streams.....	11,000
Salaries of scientific assistants.....	4,000
	<hr/>
	58,000

GENERAL FEATURES OF THE WORK.

The field examinations made for coal-land classification during the last nine years have covered approximately the following areas in townships, a township comprising 23,040 acres.

*Areas examined for coal-land classification by fiscal years from 1907 to 1915, measured in townships.*

Townships.		Townships.		Townships.	
1907 .....	296	1910 .....	322	1913 .....	188
1908 .....	583	1911 .....	339	1914 .....	183
1909 .....	443	1912 .....	358	1915 .....	96

The area remaining in coal withdrawals at the end of the fiscal year amounts, roughly, to 2,100 townships, which at the rate of examination this year will require about 22 years for classification.

The classifications of oil, potash, and metalliferous mineral lands during the year have affected smaller areas and the phosphate classifications somewhat larger areas than during preceding years. Most of the public lands in which the possibilities of the existence of valuable deposits of petroleum, phosphate, and potash are considered favorable have already been withdrawn, so that the field work of 1914-15 revealed relatively small additional promising areas, except as to phosphate. The tracing of the phosphate-bearing rocks around the west end of the Uinta Mountains in Utah added considerably to the phosphate territory heretofore known. The greater part of the nonoil and nonpotash lands had been eliminated from the reserves of those minerals as a result of earlier work. Consequently the changes in the areas reserved because of these resources have been relatively slight. Large eliminations were made from the phosphate withdrawals as a result of detailed mapping of parts of the reserves. These changes are summarized in the following table:

*Lands withdrawn and restored to entry during the fiscal year ended June 30, 1915.*

	With- drawn.	Restored.
	<i>Acres.</i>	<i>Acres.</i>
Oil.....	197,073	180,818
Phosphate.....	273,221	454,894
Potash.....	119,224	2,880

Classification discriminating metalliferous from nonmetalliferous lands during the year covered nearly 1,000,000 acres, chiefly of Indian lands in Washington, Idaho, Arizona, and California. Much the greater part of this area proved to be nonmineral land.

The first great designations of land as nonirrigable for entry under the enlarged homestead acts were made promptly upon the passage of the first act--the act of February 19, 1909 (35 Stat., 639). Large areas were designated during the two succeeding years; small areas were added during 1912 and 1913, when the regulations required that only unpatented lands might be designated; and large areas have been designated during the last two years as a result of the increasing demand and the application of the law to several new States. The gross designations made each fiscal year since the passage of the act are indicated in the accompanying table.

*Lands designated as irrigable or nonirrigable during the fiscal years 1909-1915.*

	<i>Acres.</i>		<i>Acres.</i>
1909.....	161,428,184	1913.....	2,323,612
1910.....	18,383,201	1914.....	33,102,289
1911.....	11,030,598	1915.....	17,485,259
1912.....	1,201,513		

The increasing demand for this work and the responses that the board's limited force has been able to make to this demand are indicated in the following table of petitions for designation received during each year since the passage of the act and the number of the requests acted upon:

*Petitions for designation of irrigable or nonirrigable lands received and acted on, 1909-1915.*

Year.	Received.	Acted on.
1909.....	89	49
1910.....	256	245
1911.....	248	162
1912.....	511	299
1913.....	1,944	946
1914.....	5,709	5,309
1915.....	5,666	3,996

On June 30, 1915, there were 3,327 petitions pending and under consideration.

The changes during the year in the areas withdrawn as valuable for power development have been relatively small, the new withdrawals during the year aggregating 292,134 acres and the restorations 55,646 acres, the total area included in power site reserves at the end of the year being 2,228,105 acres.

#### SUMMARY.

No coal lands were withdrawn during the year, but 2,363,646 acres were restored, leaving outstanding withdrawn at the end of the year 48,244,274 acres. There was a decrease of 113,088 acres during the year in the area of coal land to which values had been given. This decrease is due to a reclassification as noncoal of certain areas heretofore classified as coal land and appraised. At the end of the year 19,489,771 acres had been valued at an average price of \$40.60 an acre.

During the year 197,073 acres of oil land were withdrawn and 180,818 acres of nonoil land eliminated from withdrawals, leaving the net area included in oil withdrawals at the end of the year 4,774,418 acres.

The phosphate classifications during the year resulted in a withdrawal of 273,221 acres and a restoration of 454,894 acres, leaving the net area outstanding at the end of the year 2,660,376 acres.

During the year 119,224 acres were withdrawn for potash explorations and 2,880 acres were eliminated from existing withdrawals, leaving the withdrawn area at the end of the year 342,013 acres. On the basis of containing metalliferous minerals 967,210 acres, chiefly in Indian reservations, were classified. Of this total 929,916 acres were classified as nonmineral and 37,294 acres as mineral land. The

new withdrawals of land valuable for power sites during the year amounted to 292,134 acres, the restorations to 55,646 acres, leaving the area withdrawn at the end of the year for this purpose 2,228,105 acres. During the year 17,485,259 acres were classified as nonirrigable and were designated for entry under the enlarged-homestead act. The total area thus designated at the end of the year amounted to 235,596,180 acres.

#### NEW LEGISLATION.

During the fiscal year that ended June 30, 1915, several acts and amendments to acts were passed which affect the work of classifying the public lands. One of the most important of these was the act of July 17, 1914 (38 Stat., 509), which provides for "the appropriation, location, selection, entry, or purchase" under the nonmineral land laws of all lands withdrawn, classified, or valuable for phosphate, nitrate, potash, oil, gas, or asphaltic minerals with the reservation to the United States of the minerals for which the lands are withdrawn or are valuable. This act supplements the acts of March 3, 1909 (35 Stat., 844), June 22, 1910 (36 Stat., 583), and April 30, 1912 (37 Stat., 105), providing for nonmineral entry on coal lands, and permits agricultural entry and development on practically all lands now included in mineral reserves, which constitute much the greater portion of the total areas withdrawn under the act of June 25, 1910 (36 Stat., 847).

The total area withdrawn on June 30, 1915, was 58,494,844 acres. Of this total all the lands included in coal, oil, phosphate, and potash reserves, aggregating 56,021,081 acres, may now be entered under the nonmineral land laws, the remaining withdrawals of miscellaneous types, aggregating 2,473,763 acres, being not yet subject to agricultural entry. The passage of these acts thus greatly reduced the interference of the withdrawal policy with agricultural development and it can be still further reduced by a provision for agricultural entry of lands in power-site reserves with a reservation of all water-power rights to the Government. Legislation of this type has been advocated by the department, and such a provision has been included in the Ferris bill (H. R. 16673, 63d Cong., 3d sess.).

Four new laws, or amendments to old laws, were passed at the close of the third session of the Sixty-third Congress, which very definitely affect the rights of homesteaders and the procedure under the enlarged-homestead acts. The act of March 3, 1915 (38 Stat., 953), and section 2 of the act of March 4, 1915 (38 Stat., 1163), extended the residence provisions of the enlarged-homestead acts to two additional States, namely, Kansas and South Dakota, so that these acts now apply to 14 States. The amendment of March 3, 1915 (38 Stat., 956), the act of March 4, 1915 (38 Stat., 1162), and section 1

of the act of March 4, 1915 (38 Stat., 1163), constitute a series of supplementary acts which together form important new legislation affecting homesteaders and the administration of the enlarged-homestead laws. Before these acts were passed, homestead entrymen who had received final certificates or patents on 160-acre homesteads were barred from participation in the advantages of the enlarged-homestead laws. Applicants for designations under these laws secured no recognized rights or equities by virtue of their application, and before the desired additional land could be classified it might be acquired under the ordinary homestead laws by another entryman and the applicant under the enlarged-homestead act be left without remedy. The amendment of March 3, 1915 (38 Stat., 956), provides that any homestead entryman who, although he may have submitted final proof or received patent to his entry, still owns and occupies the land entered shall have the right to enter a tract contiguous to the original entry, provided that the two entries together shall not exceed 320 acres in area. Section 1 of the amendment of March 4, 1915 (38 Stat., 1163), provides that an application to enter lands under the enlarged-homestead acts shall operate to reserve these lands from other entry until the Secretary of the Interior shall have determined whether they are subject to acquisition under the enlarged-homestead act. If his decision is favorable and he designates the land, the applicant shall then have a preference right to enter the lands. This series of supplementary laws is completed by the act of March 4, 1915 (38 Stat., 1162), which provides that enlarged homestead entries which were pending on January 1, 1914, but were invalid because title to the original entry had already been acquired under the homestead laws, are validated if the original entry was for less than 160 acres.

Since the act of March 4, 1915, provides that those who desire to secure a preference right to entry, subject to the designation by the Secretary of the Interior of the lands as nonirrigable, must file their applications with the register and receiver of the land district in which the land desired is located, and since the majority of the applicants under the enlarged-homestead laws desire to take advantage of the preference right feature of this law, most of the applications are now received through the General Land Office instead of directly by the Geological Survey or the Secretary's office as heretofore. The General Land Office and the Geological Survey have provided for this new procedure. Regulations have been prepared and issued defining it and a circular on the subject may be obtained at local land offices by applicants who desire to take advantage of this act.

## CORRESPONDENCE.

During the fiscal year just closed 19,151 letters were referred to the board, an increase of about 23 per cent over the preceding year. In addition, about 6,000 copies of letters from other bureaus were sent to the board for its information and files. During the same period 18,457 letters, reports, acknowledgments, and notifications were prepared in the board, an average of about 63 incoming and 60 outgoing pieces of mail for each working day of the year.

## PUBLICATIONS.

During the year a bulletin entitled "Petroleum withdrawals and restorations affecting the public domain" has been prepared by Max W. Ball and Lucetta W. Stockbridge and submitted for publication. This bulletin gives true and accurate copies of all petroleum withdrawals and restorations. It contains chapters on purpose of the withdrawals, history of the withdrawals, oil-land law, and orders and correspondence, and is illustrated by seven maps. No bulletin of this kind has ever been published, and it is believed that it will be of great value to the Survey, to the Land Office, and to individuals interested in the oil industry in the public-land States.

## COOPERATION WITH THE GENERAL LAND OFFICE.

The cooperation between the General Land Office and the Geological Survey through which the Survey's information on the mineral and power value of lands sought under the public-land laws is made available to the department, through the General Land Office, was partly suspended during the fiscal year 1913-14 because the land board's staff and allotments were insufficient to keep the work current. As a consequence of the suspension the cases awaiting action in the Survey were nearly all disposed of by the beginning of the fiscal year 1915 and cooperation was resumed in part soon thereafter. As a result of this resumption, the Survey received during the year 9,046 requests from the General Land Office for information as to the mineral character or the relations to water supplies of public lands sought, and it furnished information in 7,364 cases. It also received 2,710 reports of the field examiners of the Land Office for consideration, and it acted on 2,576 reports of this character.

The following table shows the year's record in the several classes of cooperative cases, including those discussed and including also requests for the designation of lands under the enlarged-homestead act. With the passage of the preference-right act (38 Stat., 1163) and the tendency as a consequence to file enlarged-homestead petitions in the local land offices instead of in the Geological Survey, this type of work comes to resemble more closely, in the manner in which it is handled, the other cooperative work between the two bureaus.



General summary of cooperative cases for the fiscal year 1915.

Classes of cases.	Pending July 1, 1914.	Received during fiscal year.	Disposed of during fiscal year.	Pending June 30, 1915.	Gain (+) or loss (-).
Mineral character only:					
General Land Office requests for information....	12	451	283	180	- 168
General Land Office field service reports.....	85	1,458	1,387	156	- 71
Applications for reclassification as to coal.....	0	10	9	1	- 1
Applications for classification as to coal.....	3	18	17	4	- 1
	100	1,937	1,696	341	241
Water resources only:					
General Land Office requests for information....	14	125	118	21	- 7
General Land Office field service reports.....	16	67	65	18	- 2
Cases in national forests.....	2	67	63	6	- 4
Applications for reclassification as to water re- sources.....	13	49	51	11	+ 2
Applications for rights of way.....	110	460	465	105	+ 5
Lists under Carey Act.....	0	7	6	1	- 1
Petitions under enlarged-homestead act.....	1,657	5,666	3,996	3,327	-1,670
Desert-land proofs under irrigation projects.....	119	151	180	90	+ 29
	1,931	6,592	4,944	3,579	-1,648
Mineral character and water resources:					
General Land Office requests for information....	137	7,944	6,382	1,699	-1,562
General Land Office field service reports.....	60	659	643	76	- 16
General Land Office requests for information as to water resources, accompanied by field serv- ice reports as to mineral character.....	36	526	481	81	- 45
Indian Office requests for information.....	35	123	148	10	+ 25
	268	9,252	7,654	1,866	-1,598
	2,299	17,781	14,294	5,786	-3,487

MINERAL CLASSIFICATION.

COAL.

*Regulations.*—The regulations governing the classification and valuation of coal lands approved by Secretary Fisher February 20, 1913,<sup>1</sup> have continued in force during the fiscal year, except that by a decision of Secretary Lane on February 16, 1915, the last part of paragraph 2 was revoked, the department holding that legally classification of coal land must be made by quarter quarter sections and surveyed lots and not by minor subdivisions of 2½ or 10 acres. In the comparatively short time that these regulations have been in force they have proved the soundness of the principles underlying them. Certain modifications may become necessary as knowledge of the chemistry of coal is increased and as further statistics are collected bearing on cost of mining and other factors affecting the value of coal lands. The regulations as they now stand furnish what is believed to be a sound and conservative standard for the classification and valuation of land underlain by coal of any quality or thickness.

*Withdrawals and restorations.*—No withdrawals of coal land were made during the year. The policy of reducing the outstanding withdrawals was continued in so far as the data available and the demands of other work would permit.

<sup>1</sup> U. S. Geol. Survey Bull. 537, pp. 96-97, 1913.

*Classifications.*—During the last year, as in previous years, every effort has been made to obtain information with regard to withdrawn areas which were believed to be largely noncoal land in order that, as rapidly as possible, those areas might be eliminated from the withdrawals. The results in acreage classified—2,902,628 acres—are far below those of previous years, partly because of the previous elimination from withdrawal of the larger noncoal areas and a consequent restriction of field examination to more detailed work on coal lands, but chiefly because of the short season of field work in 1914. Reexamination of parts of Wyoming, Colorado, and Utah which had previously, on very meager evidence, been classified as coal land resulted in the reclassification of large areas, so that the net result of the classifications during the fiscal year is a reduction of outstanding classified coal lands by 24,568 acres.

In the following four tables the results of restorations, classifications, and appraisals during the year are summarized by States:

*Coal land restored during the fiscal year 1915, in acres.*

State.	Outstand- ing July 1, 1914.	Restora- tions dur- ing fiscal year.	Outstand- ing June 30, 1915.
Arizona.....	118,718	.....	118,718
California.....	17,764	121	17,643
Colorado.....	4,746,663	137,097	4,609,566
Idaho.....	338,452	.....	338,452
Montana.....	14,203,365	1,204,250	12,999,115
Nevada.....	83,833	.....	83,833
New Mexico.....	5,549,883	126,228	5,423,655
North Dakota.....	15,202,533	465	15,202,068
Oregon.....	26,561	.....	26,561
Utah.....	5,988,064	291,448	5,696,616
Washington.....	1,380,928	533,036	847,892
Wyoming.....	2,951,156	71,001	2,880,155
	50,607,920	2,363,646	48,244,274

*Coal lands classified and appraised during the fiscal year 1915, in acres.*

State.	Total classifica- tion.		Reclassification.		Net increase or decrease (shown by minus sign) in outstanding classification.		Coal land appraised.	
	Coal land with and without valua- tion.	Noncoal.	Coal land reclassi- fied as coal.	Noncoal reclassi- fied as coal.	Coal.	Noncoal.	Total coal land ap- praised.	Ap- praised coal land reclassi- fied as noncoal.
California.....	.....	121	.....	.....	.....	121	.....	.....
Colorado.....	183,302	226,793	191,544	81,454	— 8,242	145,339	182,487	191,544
Montana.....	83,635	1,278,744	72,891	1,668	10,744	1,277,076	82,117	72,891
New Mexico.....	7,073	340,394	5,448	.....	1,625	340,394	7,073	5,448
North Dakota.....	319	40	.....	.....	319	40	319	.....
South Dakota.....	.....	10	10	.....	— 10	10	.....	10
Utah.....	1,980	291,686	2,138	80	— 158	291,606	1,980	2,138
Washington.....	86,867	175,573	.....	.....	86,867	175,573	640	.....
Wyoming.....	18,039	208,052	133,752	26,595	—115,713	181,457	<sup>a</sup> 18,079	133,752
	381,215	2,521,413	405,783	109,797	— 24,568	2,411,616	292,695	405,783

<sup>a</sup> Includes 40 acres previously classified but not appraised.

*Net result of coal-land classification to June 30, 1915, in acres.*

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\* Decrease in coal areas during fiscal year is due to reclassification as noncoal of land previously classified as coal land.

*Valuation of coal lands June 30, 1915.*

\* Decrease in coal areas during fiscal year is due to reclassification as noncoal of land previously classified as coal land.

*Applications for classification and reclassification.*—During the fiscal year the Survey received 18 applications for the classification of withdrawn lands either as coal or noncoal land and 10 applications for the revision of outstanding coal and noncoal classifications. Because three of these applications asked for noncoal classification in withdrawn areas regarding which the Survey has no detailed data, and because the evidence submitted by the applicants to show that the land is noncoal was of little value, these requests were not granted. On the other hand, most of the applications for classification as coal

land have related to lignite areas, and the applicants have been able to supply sufficient information to warrant the action requested. More than two-thirds of the applications for classification have been granted. The requests for reclassification as noncoal have related mainly to areas of flat-lying beds where, because no coal is exposed on or near the land, claimants have been unwilling to accept the coal classification. Five such applications have been made and denied.

OIL.

The classification of the public lands with reference to their prospective value for deposits of petroleum and natural gas was continued during the year in California and Wyoming.

In California more than 43,000 acres, principally in Kern County, but in part in San Luis Obispo County, were restored to entry, field examination by the Survey having shown these lands to be barren of oil. No withdrawals were made in California during the year. A recomputation of the acreage included in existing withdrawals was made, however, and it indicated that the area reported as outstanding on June 30, 1914 (see Thirty-fifth Annual Report, p. 135), was too small by more than 140,000 acres.

In Wyoming, as a result of geologic evidence obtained by detailed field examination, nearly 130,000 acres were restored in Natrona County and approximately 7,500 acres in Hot Springs County. In Natrona County more than 12,000 acres, and in the Bighorn Basin, in the north-central part of the State, approximately 183,000 acres, were withdrawn as a result of field work by the Survey. The lands withdrawn in the Bighorn Basin lie largely in Hot Springs County, but include also areas in Park County and a small area in Washakie County. There was a net increase during the period of a little less than 60,000 acres in the area withdrawn in Wyoming. The areas withdrawn in Arizona, Colorado, Louisiana, and Utah have not been either increased or decreased during the year.

The following table shows the areas withdrawn during the fiscal year and the total areas included in reserves at its close:

*Oil lands withdrawn and restored during the fiscal year 1915, in acres.*

State.	Out-standing July 1, 1914.	With-drawals during fiscal year.	Restora-tions during fiscal year.	Out-standing June 30, 1915.
Arizona.....	230,400	.....	.....	230,433
California.....	1,550,848	(a)	43,301	a 1,507,547
Colorado.....	87,474	.....	.....	87,474
Louisiana.....	414,720	.....	.....	414,720
Utah.....	1,952,326	.....	.....	1,952,326
Wyoming.....	522,395	197,073	137,517	581,951
	4,758,163	197,073	180,818	4,774,418

<sup>a</sup> Recomputation of outstanding oil withdrawals in California shows that the areas previously reported should be increased by 140,404 acres.

Of especial interest during the year was the creation of Naval Petroleum Reserve No. 3. This reserve includes 9,481 acres in Natrona County, Wyo., and covers the Teapot dome immediately southwest of the Salt Creek field. This dome is as yet untouched by the drill. The lands included in the reserve were segregated from an outstanding withdrawal, so that its creation did not involve an increase in the acreage of lands withdrawn.

PHOSPHATE.

The classification of phosphate deposits in Florida, Idaho, Utah, and Wyoming was continued during the fiscal year without change in procedure. The regulations governing the withdrawal and restoration of phosphate lands have not been modified since they were adopted by the Survey on March 2, 1912.

Phosphate classification during the fiscal year was based on preliminary examinations in new areas and on detailed examinations in the withdrawn areas. These detailed examinations by the Geological Survey have resulted in material modifications of the outstanding reserves in Idaho and Wyoming. No phosphate examinations were made by the Survey in Florida, but field investigation by the General Land Office resulted in the withdrawal of a small area in that State. Of especial interest is new information, gathered during the year, showing the presence of phosphate on both the north and south sides of the Uinta Range in Utah. The reconnaissance field work in this region led to the withdrawal of additional lands, aggregating 224,558 acres, not previously known to contain phosphate beds.

The results of the phosphate examinations for the fiscal year, in so far as action toward classification has been taken, are set forth in the following summary:

*Phosphate lands withdrawn and restored during the fiscal year 1915, in acres.*

State.	Outstand- ing July 1, 1914.	Withdraw- als during fiscal year.	Restora- tions during fiscal year.	Outstand- ing June 30, 1915.
Florida.....	120,377	120	280	120,217
Idaho.....	1,001,276	5,678	40,577	965,377
Montana.....	130,215	.....	.....	130,215
Utah.....	36,193	224,558	.....	260,751
Wyoming.....	1,553,988	42,865	414,037	1,182,816
	2,842,049	273,221	454,894	2,660,376

The year's activities resulted in a net reduction of 181,673 acres in the reserves outstanding at the beginning of the year, this figure representing the excess of the restorations over the withdrawals.

POTASH.

Field work by the Survey in search of potash was continued during the fiscal year. As in previous years, the work was largely exploratory. Experimental drilling in old lake basins is being followed by

sinking deep exploratory wells. The year's activities resulted in the withdrawal of 119,224 acres in the Smoke Creek Desert, in Nevada, and in the additional restoration of 2,880 acres of unsurveyed lands west of Searles Lake, in California, included in Potash Reserve No. 2, California No. 1, other lands in that reserve having been restored during the preceding fiscal year.

*Potash lands withdrawn and restored during the fiscal year 1915, in acres.*

State.	Outstand- ing July 1, 1914.	Withdraw- als during fiscal year.	Restora- tions during fiscal year.	Outstand- ing June 30, 1915.
California.....	94,087	.....	2,880	91,207
Nevada.....	131,582	119,224	.....	250,806
	225,669	119,224	2,880	342,013

**METALLIFEROUS LANDS.**

The act of February 26, 1895 (28 Stat., 683), made provision for classifying, with respect to their mineral or nonmineral character, the lands within the Northern Pacific Railroad grant in certain land districts in Montana and Idaho, the work to be done by commissioners appointed for the purpose. The classifications made in many areas were unsatisfactory, and a reclassification was provided for in the sundry civil act of June 25, 1910 (36 Stat., 739). At the request of the General Land Office the work is being done by the Geological Survey. Field examination of these lands was first undertaken by the Survey during the field season of 1910. The work was continued during 1911, 1912, 1913, 1914, and 1915 and is nearing completion. The results of the Northern Pacific Railroad classification work for the five years are shown in the following table:

*Lands in Northern Pacific Railroad grant in Idaho and Montana classified by the United States Geological Survey, by fiscal years, 1911-1915, in acres:*

State.	1911	1912	1913	1914	1915	Total.
Idaho:						
Mineral.....	45,645	19,144	1,000	.....	.....	65,789
Nonmineral.....	90,712	53,055	1,200	.....	.....	144,967
	136,357	72,199	2,200	.....	.....	210,756
Montana:						
Mineral.....	130,386	1,134	19,800	480	6,629	158,429
Nonmineral.....	21,802	83,981	65,570	7,696	7,911	186,960
	152,188	85,115	85,370	8,176	14,540	345,389
Total:						
Mineral.....	176,031	20,278	20,800	480	6,629	224,218
Nonmineral.....	112,514	137,036	66,770	7,696	7,911	331,927
	288,545	157,314	87,570	8,176	14,540	556,145



In addition to the above work, examinations were made of the Colorado Indian Reservation in Arizona and California in 1914 for the Office of Indian Affairs, and classification of the reservation was reported to the Commissioner of Indian Affairs in March, 1915.

During the summer of 1914 an examination of the Snake River gravels in the Fort Hall Indian Reservation was completed by the Survey for the Office of Indian Affairs.

An examination of the Yuma Indian Reservation, in California, during the field season of 1914 resulted in the completion of the mineral classification for the Office of Indian Affairs, and the completed classification has been reported to that office.

During the summer of 1914 the Queniult Indian Reservation, Washington, was examined for the Office of Indian Affairs, and the lands therein were classified and reported on as to their value for all minerals except the oil and gas in a few sections.

*Metalliferous classifications made during the fiscal year 1915, in acres.*

State.	Mineral.	Non-mineral.	Total.
Arizona.....	31,934	214,048	245,982
California.....	5,360	78,338	83,698
Idaho.....	.....	447,940	447,940
Washington.....	.....	189,590	189,590
	37,294	929,916	967,210

HYDROGRAPHIC CLASSIFICATION.

WATER POWER.

*Withdrawals and restorations.*—The classification of the public lands with relation to their value in connection with water power was continued during the year, the withdrawals being made under the authority conferred by the two acts of June 25, 1910 (36 Stat., 847; 36 Stat., 858), and the act of August 24, 1912 (37 Stat., 497). On July 1, 1913, the area included in outstanding withdrawals was 1,898,405 acres. During the year 292,134 acres additional were withdrawn and 55,646 acres previously included in power-site reserves were restored to the public domain. On June 30, 1914, the total area withdrawn in connection with water power was 2,228,105 acres.

The following table shows the action taken during the year and the areas outstanding, classified by States:

*Power sites withdrawn, restored to entry, and outstanding, fiscal year 1915, in acres.*

State.	Outstand- ing July 1, 1914.	New with- drawals during fiscal year.	Restora- tions dur- ing fiscal year.	Outstand- ing June 30, 1915.
Alabama.....	120	.....	.....	120
Alaska.....	.....	68,200	.....	68,200
Arkansas.....	17,704	.....	.....	17,704
Arizona.....	190,431	147,000	.....	337,431
California.....	222,769	33,201	280	555,690
Colorado.....	270,390	.....	.....	270,390
Idaho.....	272,759	5,082	24,868	252,973
Michigan.....	.....	1,240	.....	1,240
Minnesota.....	11,020	.....	.....	11,020
Montana.....	157,041	510	2,200	155,351
Nebraska.....	761	.....	.....	761
Nevada.....	19,087	7,224	.....	26,311
New Mexico.....	13,577	.....	.....	13,577
Oregon.....	266,710	656	4,040	263,326
Utah.....	378,147	2,603	18,160	362,590
Washington.....	97,537	7,507	988	104,056
Wyoming.....	73,564	18,911	5,110	87,365
	1,991,617	292,134	55,646	2,228,105

*Applications for reclassification.*—At the beginning of the fiscal year 13 applications for the reclassification of lands included in power-site reserves were awaiting action and during the year 49 were received. Out of this total of 62 cases action was taken on 51, leaving 11 pending at the close of the year.

*Right-of-way applications.*—Departmental regulations of January 6, 1913, under the act of Congress approved March 4, 1911 (36 Stat., 1253, 1254), and of March 1, 1913, under the act of Congress approved February 15, 1901 (31 Stat., 790), charge the Geological Survey with important administrative duties in connection with applications for rights of way over the public lands for purposes relating to the development of water power. Such applications, when received in proper form at the General Land Office, are now forwarded to the Survey for consideration of such matters as relative priority of applications, incompatibility of works, relative beneficial utilization of resources, and the engineering and economic features involved in the applications and permits. If the approval of an application is found to be compatible with the public interest, a draft of agreement is prepared setting forth terms on which the use of the desired right of way is to be conditioned, and a report is made on the circumstances in the case. On June 29, 1915, the Attorney General held that the act of February 15, 1901, is applicable to the Territory of Alaska, the field for development of power under permit being thereby extended.

In addition to applications for rights of way for hydroelectric development a large number of applications for rights of way of other types are referred to the Geological Survey for consideration and report. These embrace applications for rights of way for railroads under the acts of March 3, 1875 (18 Stat., 482), and March 2, 1899 (30 Stat., 990), affecting public lands and Indian reservations, respec-

tively, on which report is made as to whether or not the construction of the railroad will interfere with power or irrigation development on streams in the vicinity of the right of way; applications for rights of way under the act of March 3, 1891 (26 Stat., 1095), for irrigation uses on which report is made as to interference with power development, the feasibility of the project, and other features; applications for rights of way across national forests for mining, milling, and municipal purposes under the act of February 1, 1905 (33 Stat., 628); and a variety of miscellaneous applications for domestic, municipal, mining, and railroad water supply. The number of each type received and the action taken thereon is indicated in the following table:

Applications for rights of way during the fiscal year 1915.

Classes.	Pending July 1, 1914.	Received during fis- cal year.	Acted on during fis- cal year.	Pending June 30, 1915.
Railroad: Acts of Congress approved Mar. 3, 1875 (18 Stat., 482), May 13, 1898 (30 Stat., 409), Mar. 2, 1899 (30 Stat., 404), etc.....	30	118	119	29
Irrigation: Acts of Congress approved Mar. 3, 1891 (26 Stat., 1095), May 11, 1898 (30 Stat., 404), etc.....	16	218	205	29
Power: Acts of Congress approved Feb. 15, 1901 (31 Stat., 790), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.....	53	31	45	39
Miscellaneous: Acts of Congress approved Jan. 21, 1895 (28 Stat., 635), May 11, 1898 (30 Stat., 404), May 21, 1896 (29 Stat., 127), Jan. 13, 1897 (29 Stat., 404), Feb. 15, 1901 (31 Stat., 790), Feb. 1, 1905 (33 Stat., 628), Mar. 4, 1911 (36 Stat., 1253, 1254), etc.....	11	93	96	8
Total number of applications for original con- sideration.....	110	460	465	105
Additional applications for reconsideration.....	47	67	76	38

NOTE.—The first application received from the Secretary's office was dated Oct. 11, 1909; from the General Land Office Nov. 11, 1909; from the Office of Indian Affairs Dec. 23, 1909.

IRRIGATION.

*Reservoir withdrawals.*—A number of reservoir sites, valuable principally for the storage of water for irrigation, have been examined by the Geological Survey, and, on its recommendation, the lands they include have been withdrawn from entry. The area included in such withdrawals at the close of the fiscal year is shown in the following table:

Reservoir sites restored to entry during the fiscal year 1915, in acres.

State.	Outstand- ing July 1, 1914.	Restora- tions during fiscal year.	Outstand- ing June 30, 1915.
Arizona.....	33,040	.....	23,040
Montana.....	15,640	.....	15,640
North Dakota.....	1,569	.....	1,569
Oregon.....	10,619	.....	10,619
South Dakota.....	8,542	8,542	.....
Washington.....	35,943	.....	35,943
	95,353	8,542	86,311

*Carey Act segregations.*—During the year 7 proposed segregation lists under the Carey Act were received for report as to available water supply, general feasibility of plan of reclamation, and mineral character of the lands, and reports on 6 of these lists had been submitted before the fiscal year closed. Supplemental reports on 3 other lists were also furnished.

*Irrigation projects.*—The Geological Survey, by instructions of the Secretary of the Interior dated March 15, 1913, furnishes to the Commissioner of the General Land Office all information at hand relative to the available water supply and the feasibility of irrigation projects whose water rights or shares are presented as evidence of compliance with the requirements of the desert-land act. During the year 151 such cases were received and 119 were carried over from the preceding year. Of these 270 cases 162 were reported on and 90 were pending June 30, 1914. Supplemental reports were rendered on 18 cases.

#### ENLARGED HOMESTEADS.

Classification of lands under the enlarged-homestead acts of February 19, 1909 (35 Stat., 639), June 17, 1910 (36 Stat., 531), and June 13, 1912 (37 Stat., 132), was continued during the year. By the act of March 3, 1915 (38 Stat., 953), the enlarged-homestead act was extended to Kansas, and by the act of March 4, 1915 (38 Stat., 1163), to South Dakota, making the act now applicable to 14 States. Designations during the fiscal year have added a large area of land to that previously classified, the added land having been included as a result of investigations of surface and underground water. The following table summarizes the work of the year:

*Enlarged-homestead designations during the fiscal year 1915, in acres.*

State.	Outstanding July 1, 1914.	Designations during fiscal year.	Cancellations during fiscal year.	Outstanding June 30, 1915.
Arizona.....	24,530,036	501,981	.....	25,032,017
California.....	850,506	1,146,092	.....	1,996,598
Colorado.....	24,293,297	539,947	111,082	24,722,162
Idaho:				
Sections 1-5.....	7,193,220	1,289,074	27,189	8,455,105
Section 6.....	53,316	33,598	121	86,793
	7,246,536	1,322,672	27,310	8,541,898
Kansas.....	.....	277,605	.....	277,605
Montana.....	42,997,071	3,766,349	2,607	46,760,813
Nevada.....	46,303,933	1,264	.....	46,305,197
New Mexico.....	19,045,996	4,328,545	.....	23,374,541
North Dakota.....	8,379,764	360,057	314	8,739,507
Oregon.....	14,869,825	2,066,723	.....	16,936,548
South Dakota.....	.....	1,756,332	.....	1,756,332
Utah:				
Sections 1-5.....	6,966,309	181,244	160	7,147,393
Section 6.....	1,217,106	2,606	680	1,219,032
	8,183,415	183,850	840	8,366,425
Washington.....	3,660,853	384,688	28,654	4,016,887
Wyoming.....	17,920,496	849,154	.....	18,796,650
	218,281,728	17,485,259	170,807	235,596,180

The general provisions of the acts, which apply in all 14 States, permit the entry by one person of 320 acres of "nonmineral, non-irrigable, unreserved, and unappropriated surveyed public lands which do not contain merchantable timber." As a prerequisite to the allowance of such entry, the land must have been designated by the Secretary of the Interior as not being, in his opinion, "susceptible of successful irrigation at a reasonable cost from any known source of water supply." Under the provisions of section 6 of the acts of February 19, 1909, and June 17, 1910, applicable in Utah and Idaho, the Secretary may further designate lands which do not have upon them "such a sufficient supply of water suitable for domestic purposes as would make continuous residence upon the lands possible," and entrymen upon such lands are relieved of the necessity of residence. By the act of March 3, 1915 (38 Stat., 956), the enlarged homestead act was amended so as to permit, under certain conditions, an additional entry, though final proof has already been submitted on the original entry.

Designations under the enlarged-homestead act are made either in large, compact areas, as a result of field investigations covering rather large districts, or in small units, as a result of investigations made at the request of prospective entrymen. These requests are referred to as enlarged homestead petitions, and because of the fact that the larger areas of land to which the acts are believed to be applicable have already been designated, the record of the year shows a large increase in the number of petitions received. This has in part been the result of the extension of enlarged homesteads to two additional States and in part of the passage of the act of March 4, 1915 (38 Stat., 1163), which provides that a preference right to enter the lands designated can be secured by the filing of an application at the local land office of the district in which the lands are situated. The following table indicates the disposition made of petitions received during the year:

*Action on petitions under the enlarged-homestead acts during the fiscal year 1915.*

State.	Pending July 1, 1914.	Received during fis- cal year.	Action taken.			Total acted on.	Pending June 30, 1915.	Cases re- consid- ered.
			All desig- nated.	Part des- ignated.	Refused.			
Arizona.....	8	51	37	2	7	46	13	3
California.....	66	333	210	0	27	237	162	10
Colorado.....	54	257	106	12	51	169	142	17
Idaho.....	481	826	473	45	397	915	392	122
Kansas.....	0	194	63	1	1	65	129	0
Montana.....	619	1,803	1,061	124	162	1,347	1,075	81
Nevada.....	0	12	3	0	0	3	9	0
New Mexico.....	42	293	174	35	38	247	88	22
North Dakota.....	67	111	131	7	17	155	23	46
Oregon.....	136	336	327	40	41	408	64	35
South Dakota.....	0	905	52	1	1	54	851	0
Utah.....	79	197	41	3	18	62	214	3
Washington.....	39	127	104	7	7	118	48	3
Wyoming.....	66	221	126	26	18	170	117	30
	1,657	5,666	2,908	303	785	3,996	3,327	372

A set of maps of the States affected, showing areas designated under the enlarged-homestead acts and the status of designations June 30, 1915, has been printed.

PUBLIC WATER RESERVES.

As information has become available recommendations have continued to be made for the creation of public water reserves, in order that important springs and sources of stock water on the desert and semiarid range lands may remain accessible to the public. Additions amounting to 19,257 acres have been made during the year to reserves of this type. The action taken is summarized in the following table:

*Public water reserves withdrawn from entry and restored to entry during the fiscal year 1915, in acres.*

State.	Outstand- ing July 1, 1914.	Withdrawn during fis- cal year.	Restored to entry dur- ing fiscal year.	Outstand- ing June 30, 1915.
Arizona.....	1,200	1,918	126	2,992
California.....	43,524	7,030		50,554
Colorado.....	480			480
Idaho.....		5,765		5,765
Montana.....		1,040		1,040
Nevada.....		1,464		1,464
New Mexico.....	1,440			1,440
Oregon.....	2,500			2,500
Utah.....	32,707	1,520	240	33,987
Wyoming.....	81,911	520		82,431
	163,762	19,257	366	182,653

PUBLICATION BRANCH.

DIVISION OF BOOK PUBLICATION.

SECTION OF TEXTS.

During the year 48,911 pages of manuscript were edited and prepared for printing and proof sheets for 21,407 final printed pages were read and corrected. This work involved the handling of 5,099 galley proofs and 35,522 page proofs. The corresponding figures for 1913-14 were 47,751 pages of manuscript, 16,786 final printed pages, 4,574 galley proofs, and 28,202 page proofs. Indexes were prepared for 66 publications, covering 16,723 pages; the figures for the previous year were 56 publications and 11,143 pages. The list given on pages 16-37 shows the number, scope, and character of the reports issued during the year.

At the close of the fiscal year eight persons were employed in this section. The water-resources branch has continued to render special assistance in copy preparing and proof reading.



**SECTION OF ILLUSTRATIONS.**

The number of illustrations prepared was 3,553, comprising 191 maps, 765 photographs prepared for reproduction, 905 diagrams and sections, 1,480 paleontologic drawings and photographs, and 212 miscellaneous. The processes used for the reproduction of the illustrations sent to the printer and the number reproduced by each process were as follows: Chromolithography and photolithography, 185 subjects; halftone engraving, 674 subjects; zinc etching, 553 subjects; wax engraving, 1 subject; cuts already engraved, 74 subjects. Proofs to the number of 2,000, including 380 revises, were received and compared critically. The finished work representing all the lithographs furnished by contractors was examined. Electrotypes of 99 cuts were furnished to outside applicants. At the close of the year material for illustrating 24 reports was in preparation.

As in previous years, a cost record has been maintained. The personnel of the section at the close of the year consists of the chief of the section, 9 draftsmen, 1 under clerk, and 1 messenger boy.

**SECTION OF DISTRIBUTION.**

The section of distribution received during the year 187 new books, 16 reprinted books, 3 new geologic folios, 17 geologic maps, 3 revised and reprinted geologic folios, 8 revised geologic maps, 4 reprints of geologic maps, 90 new topographic maps, 9 revised maps, 8 photolithographs, and 98 reprints of maps, a total of 443 publications. The total of all editions received was 689,192 books, 24,066 geologic folios, and 711,711 maps, a grand total of 1,424,969. This does not include pamphlets for administrative use, such as lists of publications and index maps.

There were distributed 596,649 books, 23,588 folios, and 487,049 maps, including 136 books, 16,583 folios, and 342,404 maps sold, a total of 1,107,286, an increase in books and maps and a decrease in folios, the demand originating from the low-priced sale of folios because of fire damage being largely satisfied last year.

The total amount received and turned into the Treasury as the result of sales of publications was \$27,711.12. The sales of topographic and geologic maps amounted to \$26,030.97, of topographic and geologic folios \$1,400.15, and of books \$280.

Sixteen persons were employed in this section during the year, and 84,788 letters were received and answered during that period.

**DIVISION OF MAP EDITING.****SECTION OF GEOLOGIC MAPS.**

This section continued in charge of George W. Stose, geologist, who directed the publication of the maps and illustrations of the geologic folios and critically reviewed all geologic maps intended for publication in other reports of the Survey.

Twenty-seven folios were handled in the section during the year. Six folios were completed and published during the year—Nos. 193 to 195, inclusive, and reprints of Nos. 112, 148, and 155, which were out of stock and were revised and brought up to date. The three new folios are noticed in the list of publications on page 36.

At the close of the fiscal year the maps and illustrations of folios 196 (Philipsburg, Mont.), 197 (Columbus, Ohio), and 198 (Castle Rock, Colo.) were complete and their texts were in proof, so that these three folios will be issued soon. The maps and structure sections of folios 199 (Silver City, N. Mex.), 200 (Galena-Elizabeth, Ill.), and 202 (Eureka Springs-Harrison, Ark.) were also printed, and the other illustrations of these folios were near completion. The maps and sections of the Colorado Springs (Colo.) folio were in press, the maps of the Leavenworth-Smithville (Mo.-Kans.) folio were in stone proof, and the maps of folio 201 (Minneapolis-St. Paul, Minn.) were engraved and in part in stone proof. The engraving of the maps for the Deming (N. Mex.), Detroit (Mich.), and Tolchester (Md.) folios was begun. The Colchester-Macomb (Ill.), Elkton-Wilmington (Md.-Del.), and Herman-Morris (Minn.) maps have been prepared for engraving, which will be begun as soon as the texts are completely criticized and revised. The Cleveland (Ohio), Pittsfield-Becket (Mass.), and Sheffield-Sandisfield (Mass.) maps have been partly prepared for engraving, but are awaiting slight field inspection. The Bellefonte (Pa.), Bessemer-Vandiver (Ala.), and Montevallo-Columbiana (Ala.) maps have been examined, but are awaiting field conference and office revision before preparation for engraving.

Two draftsmen, specially qualified to read and prepare geologic maps, sections, and other drawings, are employed in the section under the direction of the geologist in charge.

#### SECTION OF TOPOGRAPHIC MAPS.

At the beginning of the year 183 atlas sheets and maps of special areas were on hand for publication and the accessions during the year were 102, making a total of 285. Of these, 107 (90 new engraved maps, 9 engraved maps which are new editions or new in form of publication, and 8 photolithographs) were published. The following statement shows the comparative status of map editing and publication on June 30 for the last five years:

*Progress of map publication for five years ended June 30, 1915.*

	1911	1912	1913	1914	1915
Published during the year.....	86	114	101	102	107
In process of engraving.....	56	65	80	69	87
Unedited.....	95	102	105	114	91

The manuscripts edited during the year comprise 117 topographic atlas sheets and other maps prepared for engraving, 3 of which were afterward withdrawn from publication, 26 sheets of plans and profiles of 11 rivers, corrections for 128 engraved maps about to be reprinted, and 226 maps or sheets for the illustration of 33 Survey reports. The proof read comprises 98 new topographic maps, corrections to 57 old maps, 2 panoramic views, and 15 maps reproduced under contract. The index maps for 11 circulars of the series 9-323 were revised and reprinted during the year, and a text was adapted for each of 14 new State index circulars which have been published.

Six men were continuously employed in this work.

#### DIVISION OF ENGRAVING AND PRINTING.

##### MAPS AND FOLIOS.

During the fiscal year 90 topographic maps were engraved and printed; 9 topographic atlas sheets were corrected after field revision and new editions printed; and 7 State maps, scale 1:500,000, and 1 three-color topographic map were photolithographed and printed during the year, making the total number of new maps and new editions printed 107.

Corrections were engraved on the plates of 118 sheets, including 112 for reprinted editions and 6 for other purposes. Of those corrected for reprinting, including new maps (engraved and photolithographed), 206 different editions were printed and delivered to the map room. This is a decrease of 95 editions and 232,011 copies of regular office maps from the previous year.

Three new geologic folios and three reprinted folios were published during the year, the number published in the preceding year. Of the new folios one is a double folio and one (the San Francisco) contains five sets of geologic maps. State editions of two folios and octavo editions of two folios were issued during the year. Editions and partial editions of folios and octavos amounting to 24,066 copies were printed and delivered, a decrease of 4,164 copies during the year.

##### CONTRACT ENGRAVING AND PRINTING.

For the Government Printing Office the following items were printed and delivered: Illustrations for the annual report of the governor of Hawaii; annual report of the Commissioner General of Immigration; annual report of the Commissioner of Indian Affairs; annual report of the Chief of Engineers, United States Army; annual report of the governor of Alaska; annual report of the Board of Regents, Smithsonian Institution; annual reports of the War Department, volume 2 (War Document 480); Fiscal regulations, Department of Agriculture, 1915; Limnological study of the Finger

Lakes of New York, Bureau of Fisheries; American Ephemeris and Nautical Almanac, 1915; American Ephemeris and Nautical Almanac, 1918; Report on education of the natives of Alaska; Statistical Atlas of the United States, 1910; Department of Agriculture Bulletins 181, 198, and 204; Census reports, volumes 1-3, population, volume 5 (agriculture, general report and analysis); Department of Agriculture, Office of the Secretary, Report 100, Potash from kelp; Planetable manual (Appendix 7, report of the Superintendent of the Coast and Geodetic Survey, 1905); United States Coast Pilot, part 4, Point Judith to New York; Inside Route Pilot, Key West to New Orleans; Inside Route Pilot, coast of New Jersey; Revenue-Cutter Service Bulletin 3, International ice observation and ice patrol in the north Atlantic Ocean; Bureau of Mines Bulletin 98, report of the Selby Smelter Commission; Interstate Commerce Commission reports, volume 24; House Document 971, Sixty-third Congress, second session—Red Lake Reservation; illustrations for Geological Survey Bulletins 527, 531-B, 575, 576, 578, 580-K, 580-M, 581-D, 582, 586, 589, 590, 592, 592-A, 596, 600, 602, 604, 606, Professional Papers 87, 90-I, 90-J, 95-B, Water-Supply Papers 306, 309, 319, 338, 342, 343, 344, 346, 347, 348, 349, 350, 366, 367, 368, 369, Mineral Resources, The stone industry in 1912, The stone industry in 1915, and Topographic instructions of the Geological Survey. In addition, the following separate illustrations were printed and delivered to the Government Printing Office: Diagrams of six bird reservations and one elk reservation; panoramic views of Yosemite, Yellowstone, Glacier, Mount Rainier, and Crater Lake national parks; maps showing glaciers of Glacier and Mount Rainier national parks; map showing origin of the scenic features of Glacier National Park; Photometric lamp-sheet test, Form 174; township blank, Form 4-675a; map of National Zoological Park; map of the United States by counties; map of the world (Department of Agriculture); map showing the areas quarantined for the gypsy moth and brown-tail moth, 1914 (Department of Agriculture); Protractor, Form 678 (Department of the Interior); sectional diagram (Department of the Interior); identification cards (Department of the Interior); sample markings for brass caps (Department of the Interior).

The following work was done for other Government departments and bureaus: For the Forest Service, maps of 17 national forests, 11 fire folders and tourists maps, 5 proclamation diagrams of national forests, 4 enlargements of field sheets, annual programs of work, 1914 and 1915, annual estimate blank, blank form (grazing classification), diagram, Form 493, homestead entry plats, lookout station protractor, map showing national forest areas, map of North America 7½ by 10 inches, map of North America 15 by 20 inches, North America outline map, map of southern Appalachian region, United

States contour map, section diagrams, and other miscellaneous work; for the General Land Office, 1,492 township plats, 677 mineral plats, 12 State maps showing homesteads, maps of two Indian reservations, 21 plats of villa sites, and other miscellaneous works; for the Office of Indian Affairs, maps of 4 Indian reservations; for the Panama Canal, 10 maps of Canal Zone and 1 map showing Isthmus and completed canal. Work was also done for the Reclamation Service, Alaska Boundary Survey, War Department (Corps of Engineers, United States Army), Interstate Commerce Commission, District of Columbia (public schools), War Department (Students' Military Instruction Camp), Panama-Pacific International Exposition, Bureau of Mines, Bureau of Standards, Bureau of Education, Weather Bureau, Public Health Service, Department of the Interior, Smithsonian Institution, Alaskan Engineering Commission, Bureau of Lighthouses, Department of Labor, Department of Agriculture (Bureau of Chemistry), War Department (Army Service Schools and Coast Artillery School), Department of Labor (Immigration Service), Navy Department (United States Marine Corps), Bureau of Labor Statistics, Hydrographic Office, Bureau of American Ethnology, National Museum, Post Office Department, Bureau of Soils, and United States and Canada Boundary Survey. In addition to the above, a large amount of miscellaneous work was done for other divisions and branches of the Survey. This work for various branches of the Government amounted to about \$72,000; for which the division was reimbursed by transfer of credit on the books of the United States Treasury.

Work was also done for Houghton, Mifflin & Co., Heliotype Co. of Boston, Norris Peters Co., Geological Survey of New Jersey, J. M. Kennedy, Department of Chemical Engineering, University of Michigan, War Department (United States Engineers Office, Philadelphia, Pa.), and N. C. Grover, and the money received in payment for the work, amounting to about \$350, was turned into the Treasury of the United States to be credited to miscellaneous receipts. Under cooperative agreements, transfer impressions were furnished without charge to the State surveys of Kentucky, Illinois, and Pennsylvania.

There was also a large amount of miscellaneous office work, including index circulars, list of geologic folios and topographic maps, State maps, etc. This work, for which no refund was obtained, amounted to about \$4,500.

Of contract and miscellaneous printing of all kinds, the total number of copies delivered was 2,803,428, which required approximately 3,850,004 printings. The total number of copies printed, including topographic maps and geologic folios, was 3,533,726, requiring ap-



proximately 8,525,104 impressions. On requisition of the Government Printing Office, 333 transfer impressions were made and shipped by contracting printers.

#### PHOTOGRAPHIC LABORATORY.

The output of the photographic laboratory included 15,095 negatives, of which 2,378 were dry, 3,652 were wet, 664 were paper, 7,437 were field negatives developed, 964 were lantern slides, and 2,361 were photolithographic; 3,824 zinc plates, 278 zinc etchings, 248 celluloids, and 48,734 prints, of which 22,906 were maps and diagrams and 25,828 were photographs for illustrations. In addition 2,110 prints were mounted and 192 slides colored.

#### ADMINISTRATIVE BRANCH.

##### EXECUTIVE DIVISION.

The work in the executive division was of the usual scope except that the work of the stores section and the shipping and receiving clerk was transferred to the division of accounts.

*Mails, files, and records.*—During the year 138,791 pieces of mail, of which 2,443 were registered, were opened and referred. In addition, 90,395 letters were received direct by the other divisions, a total of 229,186 for the Survey.

Of the letters opened in this division, 24,037 contained a total of \$28,521.80 remitted for Survey publications, a decrease of 1 per cent in number of letters, and \$1,283.93 in amount, compared with the fiscal year 1914.

The recording, referring, filing, and mailing of correspondence required practically the entire services of seven clerks. The number of letters mailed through the division was 136,827, an increase of about 13 per cent over the preceding year. This number does not include the outgoing registered mail, which numbered 11,960 pieces, or 239,559 pieces of letter mail sent direct from the other divisions—a total of 388,346 for the Survey, an increase of 6 per cent over 1914.

*Personnel.*—The roll of Secretary's appointees numbered 909 at the close of the fiscal year, 18 more than at the close of the fiscal year 1914. The total number of changes in the personnel for the year was 586, which included 131 new appointments, 112 separations, 305 promotions, 2 reductions, and 36 miscellaneous changes.

During the year 15,037 days of annual leave and 2,771 days of sick leave were granted, being 66 per cent of the amount of annual leave and 12 per cent of the amount of sick leave which it is permissible to grant under the law; 5,288 days of leave without pay were also granted.



## DIVISION OF ACCOUNTS

During the year the handling of express and the issuing of stationery supplies from stock were transferred from the executive division to the division of accounts. 3,504 pieces of freight and express were handled during the year, 2,534 were outgoing and 2,534 were incoming, and 6,338 pieces were received from stock in the stationery room.

A condensed statement covering the financial operations for the fiscal year is given below, including disbursements to September 30. The unexpended balances of the appropriations and outstanding obligations.

*Amounts appropriated for and expended by the United States Geological Survey during the fiscal year ending June 30, 1915.*

Title of appropriation.	Appropriation.	Repayments.	Balance.
Salaries, office of Director.....	\$35,340.00	.....	.....
Salaries, scientific assistants.....	29,900.00	.....	.....
Skilled laborers, etc.....	20,000.00	.....	.....
Gaging streams, etc.....	150,000.00	\$33,634.72	.....
Chemical and physical researches.....	40,000.00	12.04	.....
Preparation of illustrations.....	18,280.00	.....	.....
Mineral resources of United States.....	75,000.00	43.33	.....
Geologic maps of United States.....	110,000.00	73,325.61	.....
Books for the library.....	2,000.00	.....	.....
Topographic surveys.....	350,000.00	1,134.72	.....
Geologic surveys.....	400,000.00	3,012.87	.....
Mineral resources of Alaska.....	100,000.00	.77	.....
Surveying national forests.....	75,000.00	3.57	.....
	1,405,520.00	111,173.13	1,294,346.87

Classification of expenditures by the United States Geological Survey pertaining to the fiscal year ended June 30, 1915.

Appropriation.	Total.	Salaries and wages.	Transportation of persons.	Transportation of things.	Subsistence and support of persons.	Subsistence and care of animals.	Communication service.	Printing, engraving, lithographing, etc.	Furnishing heat, light, power, etc.	Special and miscellaneous service.	Materials.	Stationery, drafting, etc., supplies.
Salaries, office of the Director.	\$35,198.83	\$35,198.83										
Salaries, scientific assistants.	29,800.00	29,800.00										
Skilled laborers, etc.	19,999.66	19,999.66										
Gaging streams, etc.	182,750.14	135,892.45	\$17,571.34	\$1,136.39	\$9,926.37	\$507.48	\$898.61	\$1,857.22	\$4.20	\$1,692.89	\$1,527.66	\$1,902.33
Chemical and physical researches	38,487.77	25,659.12	1,380.07	1,570.77	802.75	27.29	95.61	8.52	371.13	171.71	1,237.91	697.07
Preparation of illustrations.	18,200.41	16,973.17		1.49			19.49	972.47		1.78	3.27	189.92
Mineral resources United States.	74,792.50	67,983.71	1,704.55	76.98	1,118.03	.33	627.07	689.08		291.40	1.31	953.12
Geologic maps.	160,959.53	130,519.99	122.90	58.22	77.40		66.23	1,450.39	2,131.28	2,072.59	4,524.41	15,554.22
Books for the library.	1,326.25			4.10			.95					
Topographic surveys.	349,653.86	238,285.20	27,921.78	3,735.75	41,743.63	9,936.41	835.36	3,793.26		2,145.34	1,267.23	2,068.52
Geologic surveys.	388,413.39	304,081.61	27,623.47	2,221.29	20,233.29	4,937.20	1,191.70	6,204.24	12.35	4,509.70	446.71	2,672.62
Mineral resources of Alaska.	94,586.45	61,161.12	14,069.96	2,627.80	4,174.42	404.60	180.85	1,255.30		593.51	235.82	763.79
Surveying national forests.	73,866.19	48,178.69	4,052.65	543.90	7,673.66	5,068.84	135.58	146.20		762.25	267.76	445.73
	1,468,034.98	1,113,733.55	94,446.72	11,976.69	85,749.55	20,882.15	4,051.45	16,376.68	2,518.96	12,241.17	9,512.08	25,247.32

Appropriation.	Fuel.	Mechanic's, engineer's, etc., supplies.	Cleaning and toilet supplies.	Wearing apparel.	Forage and other supplies for animals.	Provisions.	Ammunition and explosives.	Special and miscellaneous supplies.	Equipment (including live stock).	Structures (bench marks).	Rent.
Gaging streams, etc.	\$142.63	\$381.14	\$2.65	\$35.50	\$134.21	\$172.73	\$4.55	\$97.92	\$6,121.42	\$332.00	\$2,408.45
Chemical and physical researches.	325.27	87.31	19.97	2.05	145.33	847.92		30.73	4,820.04		187.20
Preparation of illustrations.									38.82		
Mineral resources United States.		.72	10.80						978.10		357.30
Geologic maps.	95.61	558.92	276.64			18.96	7.72		3,424.06		
Books for the library.									1,321.20		
Topographic surveys.	284.10	44.77	37.19	1.34	4,726.36	3,195.06		72.08	7,345.73	2,131.10	83.65
Geologic surveys.	177.86	69.34	40.72	14.00	1,407.45	4,140.36	155.84	242.86	7,993.28		37.50
Mineral resources of Alaska.	180.91	12.51	54.81	88.65	1,361.47	2,907.07	58.72	77.73	4,292.73		84.68
Surveying national forests.	72.36	7.38	56.37	1.02	2,701.59	1,784.97		10.30	1,894.25	59.68	3.01
	1,278.74	1,162.09	499.15	142.56	10,476.41	13,067.06	226.83	531.62	38,229.63	2,522.78	3,161.79

## LIBRARY.

The library has acquired during the year all the important new publications of geologic interest or bearing on the work of the Survey. The European exchanges were somewhat less numerous than usual on account of the war. Altogether 12,795 books, pamphlets, and periodicals and 1,218 maps were received.

The cataloguing included current accessions and also the final cataloguing of older sections of the collection, embracing the geological surveys of Finland, Greenland, India, Mysore Province, Netherlands, Prussia, Rumania, the Transvaal, and the Union of South Africa; 60 sets of periodicals; and monographs on chemistry and on general, dynamic, structural, historical, and economic geology. The library furnished 777 title entries to the Library of Congress for printing; 11,968 cards were added to the catalogue.

Recorded loans numbered 8,069 books and 272 maps, this number not including the books and maps used in the library by 9,022 readers. The classification scheme and the catalogue have served as guides for the librarians of a number of geologic libraries, who have visited the Survey library and studied its working methods.

During the last nine months of the year about 600 books from the Washington City Public Library have been deposited in this library for recreative and educational reading by members of the Survey. From this deposit 1,713 loans were made, of which about 12 per cent were books on biography, poetry, travel, and the social sciences.

The bibliography of North American geology for 1913 was published as Bulletin 584. The bibliography for 1914 has been completed and is passing through the press as Bulletin 617. Work has continued throughout the year on the bibliography and index comprising all the published literature of American geology.

Exchange copies of Survey publications have been distributed promptly both to domestic and foreign libraries, with the exception of those for libraries in the countries now at war. These have been necessarily withheld until the Smithsonian International Exchange shipments shall be resumed.

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